SCHOOL OF ENVIRONMENTAL TECHNOLOGY,
FEDERAL UNIVERSITY OF TECHNOLOGY
MINNA, NIGER STATE, NIGERIA

EDITORS IN CHIEF
R. E. Olagunju
B. J. Olawuyi
E. B. Ogunbode

SETIC 2020 INTERNATIONAL CONFERENCE

BOOK OF PROCEEDINGS

MAIN THEME:
Sustainable Housing And Land Management

3RD -5TH MAY, 2021

SCHOOL OF ENVIRONMENTAL TECHNOLOGY COMPLEX,
FUT, MINNA, NIGER STATE, NIGERIA

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Federal University of Technology Minna, Nigeria

School of Environmental Technology International Conference (SETIC 2020)

3RD – 5TH MAY, 2021

Federal University of Technology Minna, Niger State, Nigeria

CONFERENCE PROCEEDINGS

EDITORS IN CHIEF
R. E. Olagunju
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PREFACE

The School of Environmental Technology International Conference (SETIC 2020) is organised by School of Environmental Technology, Federal University of Technology Minna, Nigeria. In collaboration with Massey University New Zealand, Department of Civil Engineering Faculty of Civil Engineering and Built Environment Universiti Tun Hussein Onn Malaysia, Malaysia Centre For Professional Development and Industrial Project Development School of Professional and Continuing Education (SPACE) UTM-KL Malaysia, Global Academia, Department of Architecture, Faculty of Engineering and Architecture, Istanbul Gelisim University Istanbul Turkey, Sustainable Environmental and Technology (SET) Research Group, Department of Architecture, Universiti Sains Islam.

The main theme for this year conference is "SUSTAINABLE HOUSING AND LAND MANAGEMENT". This promotes and encourage innovative and novelty for policy issues for inclusive and sustainable housing; access to finance for housing and land development; sustainable building materials; building cost management; sustainable and resilient cities; geoinformatics for land management; rapid urbanization; sustainable land use and spatial planning and gender issues in access to land.

The responses from participants for this conference are overwhelming, well attended, and successful. The operation mode was virtual for all participants who choose the oral presentation mode and physical for all poster medium presenters. Our participants are from various Universities and other sector across the globe, from countries like United State of America (USA), Turkey, Malaysia, China, Saudi Arabia, Kenya, New Zealand and South Africa just to mention a few. Hence, this conference provides a good platform for professionals, academicians and researchers to widen their knowledge and approach on latest advances in research and innovation. Papers presented in this conference cover a wide spectrum of science, engineering and social sciences.

Finally, a note of thanks must go to SETIC 2020 Local Organizing Committee (LOC) for their remarkable dedication in making this conference a success. We hope the event will prove to be an inspiring experience to all committee members and participants.

ACKNOWLEDGEMENTS

The effort put together in achieving the success of SETIC 2020 is predicated on the feat of the first and second edition of School of Environmental Technology International Conference held in 2016 and 2018, respectively. The support and goodwill from Vice-Chancellor of Federal University of Technology, Dean School of Environmental Technology, Dr Dodo Y. A., Dr Moveh S. and many other highly motivated people are highly appreciated.
It is also my privilege and honour to welcome you all, on behalf of the Local Organizing Committee (LOC) to the 3rd edition of the Biennial School of Environmental International Conference (SETIC 2020). This Conference which was earlier schedule for 7th to 11 April, 2020 is holding now (3rd to 5th May, 2021) due to the challenges of COVID-19 Pandemic and the ASUU-FGN crisis which made our public Universities in Nigeria to be closed for about one year. We thank God for keeping us alive to witness the great SETIC2020 event, in an improved form exploiting the new-normal situation posed by the Pandemic for a hybrid (i.e. both physical and virtual) form of Conference participation.

The conference provides an international forum for researchers and professionals in the built environment and allied professions to address fundamental problems, challenges and prospects Sustainable Housing and Land Management. The conference is a platform where recognized best practices, theories and concepts are shared and discussed amongst academics, practitioners and researchers. This 2020 edition of SETIC has listed in the program a Round Table Talk on Housing Affordability beyond COVID-19 with selected Speakers from across the globe available to do justice on the topic of discussion.

Distinguished Conference participants, permit me to warmly welcome our Keynote and Guest Speakers:

- Prof. Ts. Dr. Mohd Hamdan Bin Ahmad, *Deputy Vice Chancellor (Development) Universiti Technology Malaysia (UTM)*;
- Assoc. Prof. Dr. James O.B. Rotimi, *Academic Dean Construction, School of Built Environment, College of Sciences, Massey University of New Zealand*;
- Assoc. Prof. Sr. Dr. Sarajul Fikri Mohammed, *General Manager, Centre for Professional Development and Industrial Project Development School of Professional and Continuing Education (SPACE), UTM-KL.*
- Prof. Ts. Dr. Zanail Abidin Akasah, *Visiting Professor on Sustainable Solar Integrated Design Building Design, International Micro Emission University (IMEU)/HIMIN Ltd. China & Senior Research Fellow, The Architects Resourcery, Jos, Nigeria*;
- Ar. Dr. Elina Mohd Husini, *Department of Architecture, Faculty of Engineering & Built Environment, Universiti Sains Islam*;
- Asst. Prof. Dr. Yakubu Aminu Dodo, *Department of Architecture, Faculty of Engineering and Architecture Istanbul Gelisim University, Istanbul Turkey*

and the five Speakers for our Round Table Talk on "Housing Affordability beyond COVID-19"

- Dr. Muhammad Mustapha Gambo, *Manager, Policy, Research and Partnerships, Shelter Afrique, Nairobi, Kenya*;

- Prof. Dr. Soumia Mounir, *Department of Architecture Ecole Nationale d'Architecture d'Agadir [The National School of Architecture of Agadir], Morocco*
- Dr. Said Alkali Kori, *General Manager, Projects and Portfolio management, Family Homes Fund, Federal Ministry of Finance, Abuja*;
- Ts. Dr. Sasitharan Nagapan, *Department of Civil Engineering, Faculty of Engineering and Built Environment, Universiti Turn Hussein Onn Malaysia, Malaysia*;
- Dr. Mercy Nguavese Shenge, *AIA Assoc. Historic District Commissioner, City of Rockville, MD, USA.*

for accepting to share from their knowledge, wealth of experience and be available to interact with participants on varied issues on "**Sustaining Housing and Land Management**".
As reflected on the Conference program, the Conference activities will be Virtual for power point presenters to run in four parallel sessions on the Zoon platform while the participants for Poster presentations (mostly Postgraduate students) are expected to have their Posters displayed in the Environmental Complex Building of the Federal University of Technology, Minna. With a total of One Hundred and One (101) articles captured in the Conference Proceedings covering the seven subthemes of the Conference, I have no doubt that we are all in for an impactful experience at SETIC2020 as we brainstorm, exchange ideas, share knowledge and participate in evolving more approach to sustainable housing and land management drives.

I implore us all to enjoy every moment of the deliberations and ensure we maximize the great opportunity offered by the Conference to network for better research and career development as we also make new friends.

I also on behalf of myself and the LOC express our appreciation to the Dean, School of Environmental Technology and the entire Staff of the School for giving us the opportunity to steer the ship for SETIC2020. To the Reviewers and various Committees that served with us, I say thank you for helping us through despite the pressure of work.

Thanks, and God bless you all.

Olawuyi, B.J. (PhD)
Chairman, LOC
SETIC2020

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DECLARATION

PEER REVIEW AND SCIENTIFIC PUBLISHING POLICY STATEMENT

3rd May 2021

TO WHOM IT MAY CONCERN

I wish to state that all the papers published in SETIC2020 Conference Proceedings have passed through the peer review process which involved an initial review of abstracts, blind review of full papers by minimum of two referees, forwarding of reviewers' comments to authors, submission of revised papers by authors and subsequent evaluation of submitted papers by the Scientific Committee to determine content quality.

It is the policy of the School of Environmental Technology International Conference (SETIC) that for papers to be accepted for inclusion in the conference proceedings it must have undergone the blind review process and passed the academic integrity test. All papers are only published based on the recommendation of the Reviewers and the Scientific Committee of SETIC

Babatunde James OLAWUYI
Chairman SETIC2020
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ACKNOWLEDGEMENT TO KEYNOTE SPEAKERS AND GUEST SPEAKERS

SETIC 2020 organisers wishes to thank our keynote speakers, and Guest speakers for accepting to create time to share from their rich wealth of knowledge and interact with delegates and participants on varied issues being examined at this year's conference. A brief profile of each keynote speaker is provided here, this would allow for future interaction and networking with them.

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SUB-THEME 1:
POLICY ISSUES FOR INCLUSIVE AND SUSTAINABLE HOUSING

Methodological Approaches to the Socio-Cultural Studies in Residential Estates

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Abstract:

In recent times, researchers in culture and housing designs have been venturing into studies which seek to apply the people's culture and way of life in the design of their residences. This is because contemporary urban design is a borrowed concept which does not fit with the local needs of the people. They use methods for obtaining information and opinions (data) on decisions, policies, and strategies thereby involving the community and participants in all aspect of the research processes. Thus, the application of such effective methods should therefore be documented as the standard for new researchers who plan to embark on such academic undertakings; the gap which this study plans to fill. Hence, the aim of this study is to explore the methods and approaches essential for such socio-cultural studies in residential housing estates. The study puts in place the approaches for socio-cultural evaluation that takes into account local expectations.

Keywords: *Housing, Socio-cultural, Methodological, Residential estate.*

INTRODUCTION

Recently, housing has been regarded by several researchers from both economic and socio-cultural perspective. Accordingly, it became clear that contemporary urban housing does not put the people's culture into consideration; therefore, people are now trying to project their own house form, which serve as the reflection of cultural way of life and values passed down, historically (Abidoye, 2019). According to Maina (2013), socio-cultural factors are the "*intangible"* factors which has the capacity to considerably influence the planning, organizing and using of domestic spaces. Such *"intangible factors"*, as spelt out by the researcher include: basic needs, occupation, privacy, gender roles, social network, kinship and family, status, security, including institutions. By *"intangible factors*", it connotes the factors which the residential housing occupants cannot trade for anything among other housing factors like climate, economy, and materials. It can therefore be concluded that culture influences and determines on a large scale, the form and type of housing designs. Eghosa (2011), asserted that people are now seeking to reflect their culture and ideals, not only in their way of life and how they interact, but, also through their residential housing designs.

Socio-cultural research methods in housing designs refers to the techniques, orders, outlines and procedures used in carrying out socio-cultural studies. In other words, it refers, entirely, to the approaches used by researcher during some socio-cultural research undertakings that involves the occupants of residential estates. They are essentially planned and include: Observations, theoretical procedures, experimental studies, statistical analysis and approaches among others. As such, the approaches aid the researcher in data collection in a logical and coherent way. Mainly, socio-cultural research approaches in residential housing estates account for descriptions and analysis based on collected facts, quantities and observations.

Moreover, the socio-cultural empirical methods in residential housing estates are methods used in carrying out studies among members of cultural groups or different socio-cultural background and experiences. It is the overall approaches chosen to integrate different

components of the socio-cultural research in a logical and comprehensible way, thereby ensuring the study will effectively address the research problem established in such study. The intent of this paper is, therefore, to contribute to the evaluation of sociocultural studies in residential housing estates. More specifically, it attempts a classification of the approaches, it identifies and discusses it so as to ensure success.

HOUSING SOCIO-CULTURAL METHODOLOGICAL GUIDELINES

To effectively and systematically carry out socio-cultural studies in housing residential estates, the researcher needs to follow some required number of important steps to ensure success. The steps revealed, clearly, the approaches and research instruments and why they were chosen so that researchers could follow the procedures so as to obtain tangible result outcome. Connecting research methodology to the study's proposed questions and objectives will facilitates an informed approach that will assists decisions throughout the research stages.

The Development Stage

The development stage is comprised of research formulation which involves the process of outlining the research questions followed by generation of clear objective to answer the questions. Outlining a research question and objectives enables a researcher to determine the achievability of the research objectives. According to Onwuegbuzie and Leech (2006), research questions ensures the research objective and research purpose are aligned and narrowed to specific questions that researchers intend to address in their studies. The researchers also explain further that, research questions will determine the research design to be used, the sample size to be employed, including the type of instruments to be administered as well as the data analysis techniques.

LITERATURE REVIEW

This stage involves a systematic review of the literature pertinent to socio-cultural studies in residential housing estate. Andrew & Richard (2012), explained that "*The overview of literatures reviews both shows the reader what is known about a topic, and what is not yet known, thereby setting up the rationale or need for a new investigation,*" According to Webster and Watson (2002), An effective literature review creates a solid basis for contribution to knowledge and enables theory development by bridging the gap of existing body of research, and reveals areas where further research is needed. Baumester and Leary (1997) also asserted that, aspiring authors intending to do proper reviews must know that their duty is not just to gather and describe past studies, but rather to build or test theory, upon which each concept covered in the studies draws its value from how it helps operationalized or evaluate the conceptual theory. Therefore, a review of previous related works in socio-cultural studies in residential housing estates is a crucial part if one must make meaningful contribution to knowledge. Literature review comprises of both summary and explanation of comprehensive existing body of knowledge on a constricted topic, as established in academic books, conference proceedings, dissertations and published journal articles. An effective review of such prior studies creates a well-grounded base for advancing knowledge. It enables the researcher to develop concepts, fill a gap where it is found and locate areas where the study is required. Put differently, it is the section where the researcher positions the study in existing scholarly studies; critiquing the gaps of the existing scholarly studies and showing the ways in which your studies fills an existing found gap or challenges the existing socio-cultural housing studies, theories and concepts. It is also important to add that, an effective literature review

requires searching several data bases such as: OPAC (On-line Public Access Catalogues), google scholars, e-library; and not forget the use of Boolean searches. Few amongst the common mistakes in literature review as described by Baumester and Leary (1997), are as follow:

Inadequate introduction
This involves presenting a full and vigorously integrative theoretical framework early and not deferring it till later parts in a study.
Inadequate coverage of evidence
This involves summarizing the discussion of the method and results sections of the article under review concisely. That is, citing a study's conclusion and describing the method and specific results.

Lack of Integration
This has to do with ensuring that the research has been appropriately and thoroughly covered. It entails asking whether each study reviewed have been presented in a way that makes the integrative concepts and themes unambiguous.
Doing a comprehensive literature review in socio-cultural housing studies will therefore provide the required background and reveal, in clear details, how other researchers have analysed key concepts in their studies.

Conceptual framework
Conceptual framework has been accepted by researchers, across different field of studies, as one of the cogent part of every good research. According to Antonenko (2014), it is a tool for connecting context of practice, theory, and method, which he refered to as 'the trifecta of inquiry'. It is also a process, he added, of organizing research project's ideas by developing and aligning all key aspects of research.

Conceptual framework in socio-cultural housing studies therefore can be said to be the outline of the whole study, which shows how the researcher combine socio-cultural themes and concepts, together with how the variables are linked together. According to Leshem and Trafford (2007), conceptual framework shows how the researcher has operationalized the concepts, having been informed by previous literatures. This implies that, conceptual framework serves as a guiding frame that shows the details of what is to be done in the course of study, having understood the concepts, themes, and variables therein.
In socio-cultural studies related to residential housing estate, the dependent variable is the socio-cultural needs of the respondents while the independent variables could include factors like: family values, family lifestyle, social identity, family structures and many others, depending on the gap the research intends to fill. To link these variables, case study and questionnaire would serve as the tools through which adequate findings and proper inferences may be drawn, as shown in figure 1. An effective conceptual framework thus combines all relevant concepts and relationships among them, and come up with such questions and method of inquiries at the end of literature review.

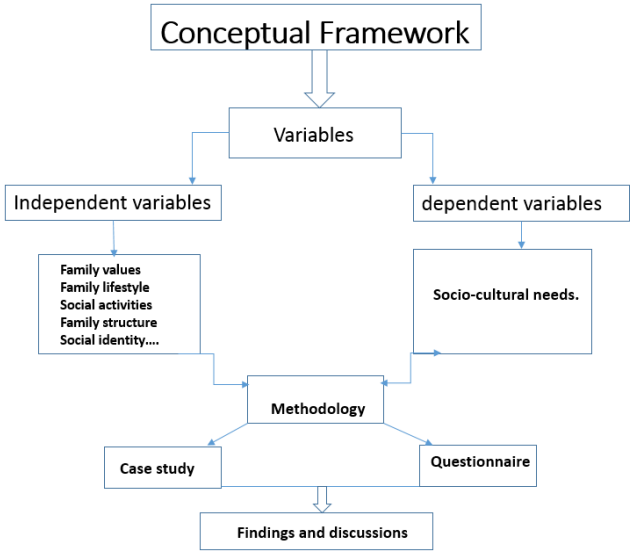

Figure 1: Conceptual framework
Source: Abidoye (2019)

Therefore, understanding the concepts of existing socio-cultural housing studies, coupled with a clear definition of variables, and how data were analyzed and recorded is of great importance; for it provides the essential foundation for the novice researchers to develop a better data collection instrument.

Research strategy

The research designs discuss the overall approach chosen to integrate different components of the socio-cultural housing study in a logical and coherent way, thereby ensuring the study will effectively address the research problem. In undertaking socio-cultural housing studies in residential estates, both qualitative and quantitative (mixed use) approach may be employed (table1). According to Oluigbo (2011), qualitative approach in architecture is used for exploring into the course of study for the purpose of gaining insight into the problem. It often involves the use of observations, visual survey, alongside well-structured interview of major components and variable of the study. Quantitative approach on the other hand, is used to generate information (data), through well-structured questionnaire, from respondents which would be summarized into statistical inferences. Thus, quantitative approach could be used to examine the existing residential estates, while qualitative approach is employed to generate opinions and behavior regarding socio-cultural factors of respondents.

Table 1: qualitative and quantitative approaches

	Qualitative	Quantitative
Social theory	Action	Structure
Methods	Observation, interview	Experiment, survey
Question	What is x? How? Why? (classification)	How many xs? (enumeration)
Reasoning	Inductive	Deductive
Sampling	Theoretical	Statistical
Strength	Validity	Reliability

Source: WHO (2014).

Case study

Case study are crucial in socio-cultural housing studies in residential estates in that, it allows for proper presentation of data obtained from surveys, interviews, observations as well as document review so as to offer a complete record of the cases chosen. Oluigbo (2010) submitted that, for cases to be selected, they have to possess some essential features which are in relation with the phenomenon under considerations. Consequently, for socio-cultural housing study in residential estates, depending on the aim and objectives, an also the criteria for variable documentations of the study, case study may be purposively selected; and such criteria should be followed containing the study's variable as shown in table 1.

Table 2: Sample of a checklist

Socio-cultural requirements	Rating				Comments
	A	L	M	H	
Case study					
Outdoor recreation/relaxation Green Spaces					
Use of local arts, crafts, ornaments and decorations.					
Provision of space for local socio-cultural ceremony					
Reflection of local life style.					
Uniqueness of design.					
Provision for local socio-cultural activities					
Reflection of local life style.					
Uniqueness of design.					

Source: Abidoye (2019).

Population of the study

Population is the cumulative of all the groups that share some mutual set of characteristics. It can also be referred to as group of individuals, objects or items from which samples are taken for measurement (Kombo & Delno, 2006). Therefore, the targeted population for which socio-cultural housing study in residential estate is been carried out should be spelt-out, depending on the aim and objectives. This is to clearly understand who the respondents of the study are.

Sampling size

Since it is generally impossible to study an entire population in socio-cultural housing in residential estates, researchers usually rely on sampling to get a unit of the population to be able to perform an experiment or observation study. Following the aforementioned, it is important that the group selected be the representative of the population, and not partial in a methodological approach. Thus, in socio-cultural housing studies of residential estates the researcher may use non-probability sampling and purposive selection of case study within the housing estate selected. Researcher could also use simple random and proportional random sampling methods, which follows the postulation of Yalams and Ndomi (2000) that, sample selection is best done by randomization which will ensure that every element in the population has equal chance of being selected to obtain unbiased sample for the socio-cultural housing study.

Data collection instrument

There are different instruments that could be used for collecting data information in socio-cultural housing studies in residential estate. However, the major instrument of data collection is through the administration of questionnaire; which is a well-structured, formally designed form provided for the respondents to fill. The questionnaire is usually separated into two sections: Section A, which is the detail of demographic biodata, and Section B which are sets

of specific, well-structured questions on socio-cultural housing parameters of residential estates as indicated in Table 2.

Table 2: Sample of a questionnaire for socio-cultural housing in residential estates

Instruction: Please indicate the appropriate response by ticking (√) the column that best suit your opinion.
Keys: NT – Not True ST – Slightly True MT–Moderately True VT – Very True ET – Extremely True

S/N	Housing and Socio-cultural features and attributes	NT	ST	MT	VT	ET
A	**Family Values**					
1	Bedroom for house help in the compound is very important.					
2	I am comfortable with female members receiving guests in the living room other than private room.					
3	I prefer spaces for family trade & business to be at the outdoor spaces of the house.					
4	I am always comfortable when interacting with neighbours at the entrance veranda of the house.					
5	I am comfortable with how local traditions and customs are taken into consideration in the house					
B	**Family Lifestyle**					
6	There is a permanent room set aside for guest in the house					
7	I am generally uncomfortable living among staff of lower academic status in the neighbourhood					
8	There are times traditional food preparation are carried out in the compound					
9	I am not usually comfortable to relax with family and friends at the outdoor area of the house					
10	I would prefer to move into another house that reflect my status if available					
C	**Social Activities**					
11	Children playing area is not important because I dislike my children playing at the outdoor area in the compound					
12	Spaces for local events and social gathering are not supposed to be within the neighbourhood					
13	You sometimes have to keep late night on campus because there is no study room in the house.					
14	I am not comfortable with the distance to place of worship in the neighbourhood					
D	**Family Structure**					
15	Children should not be given separate room but should be with their mother in the house					
16	Family relation living with me may share the same room with my adolescents in the house					
17	I prefer to have separate bedroom from my wife					
18	Additional rooms should be incorporated to match household structure in the house.					
19	There should be separate bedrooms for adolescents' boys and girls in the house					
E	**Social Identity**					
20	I am comfortable with the appearance of the house					
21	I enjoy hosting ethnic and neighbourhood events in the community than private hall					
22	Some elements of the house reflect your ethnic identity.					

Source: Abidoye (2019).

To develop this questionnaire, the researcher might need to check up on some of the socio-cultural housing studies in residential estates such as that of Jiboye (2004), Olotuah (2015), Maina (2013), Isah, Khan and Davies (2015), and many others.

Additionally, data collection should be organised in a logical order so as to yield effective result. Organizing, and clarifying the data collection process in a simplified manner are the essential benchmarks for developing a uniform data collection instrument in socio-cultural housing estate study. It is therefore important that each variable be captured with the intent of obtaining a simple and clear responses from respondents. The data collection instrument could be a paper or an electronic document.

Survey ethics

It is not a good idea to begin the conduct of socio-cultural housing study in residential estates without the approval of the estates area where the researcher intends to carry out the survey. It is important therefore, to have a means of identification and a letter of introduction, so as to gain audience and be able to obtain approval from appropriate quarters within the residential housing estate.

This will grant the researcher access to the required information and the procedures required to get the audience of the respondents. It is also important to note that, the requirement for one residential housing estates may differ from that of another; as each may require different procedures and strategies to access information (data).

To avoid harassment, it is recommended that the researcher contact the security agents in each residential housing estate, as they could provide valuable time-saving specific information and assistance that could hasten the needed access to respondents.

Data collection

To collect data successful, it is crucial to recognize the specific requirements for each estate under considerations. Depending on the type of survey, there is need to determine the techniques and the approaches involved before selecting and training assistants. That is, a number of considerations must be well-thought-out, such as, who to address the letters of introduction to, how to access the household heads, opening hours and access within the estates, and strategies regarding photograph taking and how to conduct interview with respondents, if necessary. Any of these can influence effective data collection and require clarity before embarking on the survey.

Additionally, regarding research assistants, it is expedient for the researcher to wisely select and train them. Most importantly, it is better to select assistants that understands and could speak the language of the people under consideration. While it may also be helpful to consider selecting assistants (may be undergraduate students) from architecture departments, the researcher must also understand that the number of assistants is dependent on the number of questionnaires to be distributed and the time schedule for the survey (data collection). Moreover, research assistants should be properly trained with the data collection instrument (questionnaire), including the etiquettes and guidelines that follows such procedures.

Essentially too, it is important to do a reliability test of the data collection instrument by conducting a pilot study; during which the data item is scaled for reliability testing using reliability analysis of SPSS or STATA. Thus, according to Siegiel and Stephens (1999), the reliability of an instrument becomes reliable (or not) following the assertion that: reliability of an instrument reduces with nearness to of the reliability coefficient to zero (0), while its reliability increases with nearness to one (1). In other words, an instrument of reliability coefficient between zero (0) and one (1) is considered reliable as shown in table 3

Table 2: Sample of a checklist

Reliability Statistics	
Cronbach's Alpha	N of Items
.931	22

Source: Abidoye (2019).

Data Analysis and Presentations

Appropriate descriptive and statistical analysis should be used to analyse data obtained. According to WHO (2014), "*Data reporting should be presented in both textual and visual formats (such as diagrams, maps, graphs, tables). Organizing and displaying the data in visual formats is useful in identifying trends and forecasts".* Thus, Frequency and percentage should be employed using descriptive statistics, graphs, tables, and charts; the interpretation of which will avail the researcher the possibility to draw appropriate inferences into various themes.

CONCLUSIONS

The paper has offered a clear approach for conducting socio-cultural research studies in residential housing estate. Following these steps will increase the scientific rigor through a standard process required in carrying out such scientific studies. It will guide the researcher undertaking socio-cultural study in residential housing estate in the process of conception and development, definition of variables, and sampling process. The strategies outlined for data collection will assist in minimizing limitations and strengthen the reliability of collected data. This methodological approach enables researchers to effectively conduct research that informs and contributes, meaningfully to the scientific body of knowledge.

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A Critique of the Trusteeship Position of the Governor in the Land Use Act

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Abstract:

The trusteeship policy of the Land Use Act, 1978 ('the Act') is contained in section 1 of the Act which vests all land in the territory of each state in the Governor to hold in trust for the benefit of Nigerians. The policy is intended to achieve certain objectives which include: to secure for all Nigerians right of access to land for building, industrial, housing, and agricultural purposes, to enable government control the use to which land can be put in all parts of Nigeria thereby facilitating physical planning and development of infrastructure. However, the exact import of section 1 of the Act has been a subject of divergent interpretations. Thus, the nature of the trusteeship position of the Governor is shrouded in controversy. This paper employs the doctrinal method of research to critique the import of the concept of trust created under section 1 of the Act, and the objective is to determine whether the Governor is a trustee in relation to the land that are vested in him. The paper reveals that the Governor is a trustee in a special sense in respect of the land in his state. Therefore, it is suggested that the Governor should exercise his powers in a fair and just manner in accordance with the principles of trusteeship. More so, the Act should be amended to enable citizens to hold the Governor as trustee to account for exercise of his powers.

Keywords: Land, Trusteeship, Trust, trustee, Governor.

INTRODUCTION

Before the advent of the Europeans and subsequent establishment of the colonial government, it was a trite law that land belongs to the community, the village and the community, and the concept of individual ownership was foreign to native ideas.[1] This position reiterated the fact that the family or village head is considered as a 'trustee' because in African land jurisprudence, there is no terminology such as 'ownership'.[2] The family, village or communal head held such land for the benefit of their families, village or communities.

In the Land Use Act, 1978[3] (herein after referred to as 'the Act') the Governor is vested with the power of general administrative control and management of all land in his state.[4] To ensure the realization of the objectives of the Act, it entrenches the trusteeship policy as contained in the preamble to the Act as follows:

> An Act to vest all land comprised in the territory of each state (except land vested in the federal Government or its agencies) solely in the Governor of the State, who would hold such land in trust for the people and would henceforth be responsible for allocation of land in all urban areas to

[1] *Ahmadu Tijjani v. Secretary* (1921) AC at p. 401.

[2] Aboki, Y. (2005) "Land Use Act and Foreign Investment in Nigeria". In: Chukkol, K.S. et al (eds.) Contemporary Issues in Nigerian Law. Faculty of Law, A.B.U., Zaria, p.14.

[3] Calp.L5, Laws of the Federation of Nigeria, 2004.

[4] Section 2 (1) of the Act.

> individual resident in the state and to organizations for residential, agriculture, commercial and other purposes while similar powers will with respect to non-urban areas are (sic) conferred on Local Governments.

Section 1 of the Act also provides as follows:

> Subject to the provisions of this Act, all land comprised in the territory of each state in the federation are hereby vested in the Governor of that state and such land shall be held in trust and administered for the use and common benefit of all Nigerians in accordance with the provisions of this Act.

It has been submitted that the trusteeship policy of the Act unlike the one adopted in the Land and Native Right Ordinance that secured for member of ethnic groups the use and occupation of land, and permitted discrimination against members of other ethnic groups, aims at securing the implementation of objectives of national policies and make land available to Nigerians.[5] When the Act was enacted in 1978, it looked good and promising. The preamble to the Act and the provisions of section 1 of the Act eloquently expressed this sentiment. However, the objectives of the Act have not been fully achieved due to poor implementation of the Act with the result that land is less available to the ordinary Nigerian than it was prior to the Act.[6] More so, the implementation of the Act has brought untold hardship to many Nigerians.

The aim of this paper is to examine the trusteeship policy of the Act, and determine whether the policy has constituted the Governor into a trustee for the purpose of managing the land for the benefit of Nigerians. The paper employs the doctrinal method of research through the use of legislation, decided cases, books, and articles; and the geographical scope of the paper covers the whole country because the Act is a federal legislation that applies to the 36 states and the Federal Capital Territory. However, it has been argued that the Act merely adopted and extended the customary principle of trust by which head of family or village head held land in trust for the family or community.[7] The objective is to ascertain how the trusteeship policy by which the Governor's position may be described as a trustee can be employed to enhance the implementation of the Act, and realize its objectives.

THE PHILOSOPHY OF THE ACT

One of the policies adopted by the Act was the trusteeship policy which embraced many of the essential principles of the Northern Nigeria Land Tenure Law of 1962. The trusteeship policy differs from the paternalistic one in the sense that while paternalism aimed at securing for members of ethnic groups the use and occupation of land, and permitted discriminatory conduct against members of other ethnic groups, trusteeship aims at securing the implementation of fundamental objectives of national policies, and proscribes discrimination in land matters.[8] The

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[5] Madaki, A.M. (2006). The Land Use Act Policies: An Overview. Journal of Private and Comparative Law, Department of Private Law, Ahmadu Bello University, Zaria, p.86.

[6] Olong, A.M.D. (2011) Land Law in Nigeria. Malthouse Press ltd, Second Edition, Lagos, pp.144-145.

[7] Usman, A.K. (2014). Law and Practice of Equity and Trust. Malthouse Press ltd, Lagos, p.149.

[8] James, R.W. (1987) *Nigerian Land Use Act: Policy and Principles.* University of Ife Press Ltd, Ile-Ife, p.27.

method of achieving this was by vesting all land in the Governor in trust for the benefit of all Nigerians. This policy of trusteeship forms the basic philosophy of the Act which is to ensure that every Nigerian has access to affordable land for residential, commercial, industrial, and agricultural purposes.[9]

THE CONCEPT OF TRUST

The concept of trust is very difficult if not impossible to define but its essential elements are reasonably easily described and readily understood. There have been very many attempts to produce a definition of a trust but such definitions are either long amounting to descriptions rather than definition or shorter but susceptible to criticisms.[10] Thus, no one has yet succeeded in giving an entirely satisfactory definition of a trust. In Underhill's Law of Trust, a trust is defined as "an equitable obligation, binding a person (who is called a trustee) to deal with property over which he has control (which is called the trust property) for the benefit of persons (who are called the beneficiaries or *Cestui que trust*) of whom he may himself be one and any one of whom may enforce the obligation".[11] But this definition is not altogether satisfactory for it is not wide enough to cover trust for purposes rather than persons. Trust for charitable purpose (e.g for the repair of a church or the prevention of cruelty to animals) may lack human beneficiaries and yet be valid as trust, and there may also be other trusts which lack beneficiaries who can enforce them. [12]

However, professor Keeton seems to give a fairly satisfactory definition which includes all the significant features of a trust. He defined trust in the following words: [13]

> All that can be said of trust therefore, is that it is the relationship which arises wherever a person called the trustee is compelled in equity to hold property, whether real or personal, and whether by legal or equitable title, for the benefit of some persons (of whom he may be one and who are termed cestuis que trust) or for some objects permitted by law in such a way that the real benefit of the property accrues not to the trustee but to the beneficiaries or other objects of the trust.

This definition has been adopted by the Nigerian Supreme Court in the case of *Huebner vs. A.I.E. & P.M. Co. Ltd*[14] as the definition of trust, and being a decision of Superior Court of Record, it is as authoritative as legislation[15]. Difficult, however though it may be to give a simple, yet satisfactory definition of a trust, it is easy enough to grasp the general idea of it,

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[9] Utuama, A.A. (2012) Nigerian Law of real Property. Malthouse Press Ltd, Lagos, pp. 263-264.

[10] Stockwell, N. and Edwards, R. (2002) *Trusts and Equity.* Pearson Education Limited, England, p.7.

[11] Megarry, R. and Baker, P.V. (1973) Snell's Principles of Equity. Sweet & Maxwell Ltd, London, Twenty-Seventh Edition, p.87.

[12] Ibid.

[13] Jegede, M.I. (1999) *Law of Trusts, Bankruptcy and Administration of Estate.* MIJ Professional Publishers ltd, Yaba, Lagos, p.11; Taiwo, A. and Akintola, O. (2016) *Introduction to Equity and Trusts in Nigeria.* Princeton & Associates Publishing Co. Ltd, Ikeja, Lagos, pp.199-200.; Megary, R. and Baker, P. Op. Cit.p.87.

[14] (2017) 14 NWLR (pt. 1586) p.397 p.442, paras. E-F.

[15] Aboki, Y. (2009) *Introduction to Legal Research Methodology.* Tamaza Publishing Company limited, Zaria, Second Edition, p. 16.

which is that a trustee is one person in whom property is vested for the benefit of another person or for some purposes other than his own. It has been said, somewhat broadly, that all that is necessary to establish the relation of trustee and *cestuis qui trust* is to prove that the legal title was in one person while the equitable title is in another person.

It is therefore better to say the trustee is the nominal owner of the property while the *cestuis que trust* is the beneficial owner.[16] The ownership of the trustee creates a special relationship (fiduciary in character) with respect to trust property. This relationship imposes on the trustee certain equitable duties and obligations, enforceable in equity against the trustee by a person (beneficiary under the trust) who has beneficial interest in the trust property. Along with the trustee's duties and obligations, there are vested in him certain powers and discretions the purpose of which is efficient control and management of the trust property. The trustee is absolutely responsible for the exercise of his powers (with some statutory restrictions) though in equity, he must exercise these powers in accordance with the instrument creating the trust and for the benefit of the beneficiaries.

The origin of the English law of trusts bristles with difficulties, and in the language of a modern Equity scholar, the ultimate origin of the concept of trust is still one of the controversial topics of jurisprudence.[17] The enforcement of trust by the Chancery is perhaps the most outstanding interference with the common law jurisdiction because the Chancery's exercise of its exclusive jurisdiction in the enforcement of trust is likened to legislative power, in the sense that the Chancery not only deprived the legal owner of property of all the benefits in the property, but also created a distinct title in the same piece of property in the beneficiary.[18] Such an act of ingenuity demonstrated by the Chancery cannot but be of interest to both early and contemporary Equity scholars. Broadly, there are two major schools of thought with respect to the origin of trust, and each of these schools has attracted eminent disciples.[19] Scholars like Blackstone, Spence and Story hold the view that English law of trusts evolved from the Roman *Fidei Commissum* which is disposition of property through inheritance.[20] On the other hand, the second School of thought believes that the origin of trust has no connection with Roman law. Rather, Maitland traced the English use or trust to the Law of Agency in England.[21] These rules of agency were later adopted in conveying land to the Borough Community to the use of Orders like Franciscan Friars who because of their vow of poverty could not own any property.[22] Thus, it has been contended that uses or trusts are natural outcome of ancient English elements, having their foundation in the common law rules of Agency.[23]

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[16] Megary, R. and Baker, P. Op. Cit.p.88.

[17] Jegede, M.I. (1999) *Op. Cit.* p.1.

[18] Ibid. pp.1-2.

[19] Ibid.p.2; Jegede, M.I. (2004). An Overview of the Concept of the Concept of Trust. In: A.A. Utuama. And Ibru, G.M. (Eds.). *The Law of Trusts and Their Uses*. Malthouse Press Limited, Lagos, p.2.

[20] Usman, A.K. (2014) Law and Practice of Trust and Trust. Malthouse Press Ltd, Lagos, p.145.

[21] Usman, A.K. Op. Cit. p.143.

[22] Ibid.

[23] Ibid.

Holmes takes a view similar to Maitland. He traces the origin of Uses to Salman of the early German Law. Like a trustee to whom land was conveyed that he might deal with it according to his grantor's directions, Salman held to the use of the grantor, in grantor's life time, and later to be disposed of after grantor's death, according to grantor's directions.[24] The essence of the relation thus created from this transaction was the *Fiducia* or trust reposed in the *Fidelis Manus* who confirmed his obligation by an Oath or Covenant. The Salman was an executor, and in the early years of uses, there was little or no distinction between executor and foefee to use. Holmes concludes, because of the close connection between Anglo-Norman law and Frankish tradition that Uses must have originated from Salmon.[25] The foundation of the claim is the *fides*, the trust reposed and the obligation of good faith, and that circumstance remains as a mark of ecclesiastical origin of the jurisdiction. [26] It is not an easy task to discredit any of these theories about the historical origin of uses or trust. First, all the theories point to what may be the origin of use; and second there is difficulty of checking the various historical connections with the suggested origins. However, whatever may be the origin of trust, it is to the early Chancellors that the modern Anglo-American law of Trust owes its development. The progenitor of the trust was the Use (from the Latin *ad opus*) which was developed as the response of equity to the shortcomings of the common law.[27]

Trustee is one who, having legal title to property, holds it in trust for the benefit of another, owes a fiduciary duty to that beneficiary.[28] This relationship imposes on the trustee certain equitable duties and obligations, enforceable in equity against the trustee by a person (beneficiary under the trust) who has beneficial interest in the trust property. Along with the trustee's duties and obligations, there are vested in him, certain powers and discretions the purpose of which is efficient control and management of the trust property. The trustee is absolutely responsible for the exercise of his powers (with some statutory restrictions) though in equity, he must exercise these powers in accordance with the instrument creating the trust and for the benefit of the beneficiaries.

THE TRUSTEESHIP POLICY OF THE ACT: IS THE GOVERNOR A TRUSTEE?

The Act which came into force on 29th March, 1978 not only swept overboard all the land tenural arrangements in both the Northern and Southern parts of the country, but also introduced a system of land tenure which is completely alien to the southern parts of the country.[29] One of the distinctive features of the Act is the trusteeship policy which is stated in the preamble and section 1 of the Act. The provisions of the preamble and section 1 of the Act set out the trusteeship policy of the Act which appears to designate the Governor as a trustee of the land vested in him for use and benefit of Nigerians. However, there has been divergence

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[24] Jegede, M.I. (1999) Op Citp.5.

[25] Ibid.

[26] Ibid.

[27] Watt, G. (2008) *Trusts and Equity.* Oxford University Press Inc., New York, Third Edition, p.8.

[28] Black's Law Dictionary, West, Eighth Edition, p.1553.

[29] Mban, B.A. (1991). "The Problems of Land Acquisition and Administration in the Public Sector". *Land Use Act. Administration and policy Implication: Proceedings of the Third National Workshop* held at the Nigerian Institute of Advanced Legal Studies, University of Lagos, from April 9-11, 1990, Department of Private and Property Law, University of Lagos Press, p. 93.

of opinions on the effect of section 1 of the Act. That is to say, has the section established trust with the Governor as a trustee for the benefit of Nigerians as beneficiaries? Prof. Usman is of the view that section 1 of the Act created a trust, and the Governor is a trustee of all land in his state. According to Prof. Usman, the Act did not create new principle of trust as it is often widely credited with; rather, it merely adopted the principle of trust under customary law by which the head of the family or community held land in trust for the family or community.[30]

Prof. Fabunmi holds the same view as prof. Usman. According to Fabunmi, the idea of trust which was the underlying philosophy of family or communal land under customary law was also the underlying philosophy behind the Act.[31] He distinguished the type of trustee under English law from the trustee under the Act, and concluded the Governor is a special kind of trustee.[32] This position was supported by the Supreme Court in *Nkwocha v. the Governor of Anambra State & ors,* where Irikefe, JSC said that the Act created a legal trust constituting every Governor as trustee in respect of land within the limits of his state for the benefit of all Nigerians.[33] Prof. James is of the view that by section 1 of the Act, a trust for the benefit of the people of the state was imposed on the Governor. The Governor likewise acts as a trustee in exercising his powers of management and control.[34] This interpretation however, has given rise to difficult questions concerning the nature of the Governor's title.

According to Taiwo (2011), section 1 of the Act vests the radical title to the land in the Governor upon trust; the Governor is not beneficially entitled to the land so vested in him, but he is only a trustee of the land for the benefit of all Nigerians in that state.[35] In this regard, he holds only nominal ownership of land because a settled principle of law dictates that a trustee is not the real owner of a trust property but only has control and holds nominal title in the land for the purpose of accomplishing the objectives of a particular trust.[36] Therefore, the Governor is a trustee for the purpose of achieving the objectives of the Act.

Abugu (2008) argued that the Governor is no more than a replacement of the trusteeship of customary law such as Oba of Benin or head of family or community.[37] Thus, in *Oni v. Johnson*[38], the court held that upon the promulgation of the Act, the position of Oba as trustee of Benin land became vested in the Governor. The vesting of radical title in the Governor presupposes the existence of other titles which may be less than radical titles which is vested

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[30] Usman, A.K. Op. Cit. pp.148-149.

[31] Fabunmi, J.O. Op. Cit p.200.

[32] Ibid. p.202.

[33] (1984) 6 S.C. p.362 at p. 364.

[34] James, R.W. (1987) *Nigerian Land Use Act: Policy and Principles.* University of Ife Press Ltd, Ile-Ife, p.33.

[35] Taiwo, A. (2011). The Nigerian Land Law. Ababa Press Ltd, Ibadan, p.205.

[36] Ibid.

[37] Abugu, U.(2008) *Principles of the Land Use Act, 1978.* Joyce Graphics printers and Publishers, Kaduna, pp.13-14.

[38] (2015) LPELR-24545 (CA)

in other persons.[39] The other titles may safely be described as the equitable title while the radical title which is vested in the Governor is the legal title. Thus, while the legal title has been taken away, section 34(2) and section 36(2) of the Act preserve the equitable right of possession, occupation and enjoyment of all previous owners, be it in urban or rural areas.[40]

However, according to Tobi (1992), the legal effect of section 1 read with the provision relating to the right of occupancy is that it is no longer possible to own land allodially. What is capable of ownership is not the land itself but the right of occupancy.[41] What the Act has done has been to substitute for the concept of absolute ownership of land that of modified ownership.[42] Thus, while all the views emphasize that the Governor holds land in trust for all Nigerians, the nature of the trust created is not clear. A position that tends to undermine the concept of trusteeship in the Act was put forward by Balogun J who stated in *Adewunmi v. Ogunbowale* as follows:[43]

> The concept of trusteeship is used in section 1 of the Land Use Act as enacted, in a loose sense. It is not intended to confer upon every citizen of Nigeria the benefit which a beneficiary has against the trustee under the common law. No Nigerian citizen can under the section as enacted claim against the 'military Governor' an account for any benefits accruing from land held by him under the Act in trust and administered by him for the common benefit of all Nigerians.

Similarly, the Supreme Court in *General Cotton Mill Ltd. v. Travellers Palace Hotel*[44] appeared to kick against the trusteeship position of the governor when it held that under the Act the rights of individuals to land are limited to only the use and occupation of the land and by virtue of Section 1 of the Act all title and proprietary rights of all lands in a state are vested in the Governor, the control and determination of the use are also vested in the Governor, no person has proprietary right over any land in the state.[45] Whichever way one views the divergent views on the issue, it can be argued that Nigerians are intended to be the beneficiaries under the Act while the governor is a trustee. It is however not the type of trust known under English Law. It was thus submitted that when the Act is considered as a whole, there is no basis of comparison between the word 'trust' in the Act and concept of trust under English jurisprudence.[46]

The approach of the historical school of jurisprudence can also be employed to ascertain the nature of trust contemplated in the preamble and section 1 of the Act. The historical school of

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[39] Ibid., p.14.

[40] Ibid.

[41] Tobi, N. (1992) *Cases and Materials on Nigerian Land Law.* Mabrochi Books, Lagos, p.32.

[42] Ibid.

[43] (unreported) Suit No. ID/115/81 of 28/5/82.

[44] (2018) LPELR-46311 (SC)

[45] Ibid.

[46] Ibid.p.89.

law posits that every law is rooted in the past, and legal norms are not the product of abstract reasoning.[47] Therefore, to appreciate the import of 'trust' in section 1 of the Act, it is necessary to trace the genesis of the concept of 'trust' in the Act which is an offshoot of the Land Tenure Law. The Land Tenure Law provides that lands are held and administered for the use and common benefit of the local people, and no title to the occupation and use of any such lands by an outsider is valid without the consent of the permanent secretary.[48] Section 5 of the Land Tenure Law further provides that the lands within the meaning of section 4 will "be held and administered for the use and common benefit of the natives." Thus, the question is, do the provisions of sections 4 and 5 of the Land tenure Law imply 'trusteeship'? It will be recalled that Sir Federick Lugard in his report on the amalgamation, made the position clear when he said that "government is pledged by terms of the Land and Native Rights Ordinance (and indeed it is the root basis on which the policy of the country has been moulded) to act as trustee for the natives in regard to the land".[49]The foregoing statement of Sir Frederick Lugard is supported by prof. Elias who said:[50]

> The language of the land legislation in Northern Nigeria is clearly unfortunate, and the reluctance on the part of the government to make theory accord with practice has been largely responsible for the controversy which has ranged round the question of government title to land in the Northern provinces. In theory, crown ownership was included particularly in all early legislation in the most absolute terms; in practice however, it does not seem that the British crown asserted more than a mere right of administrative control over the land in the hinterland. The legal position then would be that the British crown claimed not as absolute owner, but as trustee of the land in the North.

The submission of Prof. Elias is that land in Northern Nigeria was held by the government on trust for the people. Thus, notwithstanding the differences of opinions among scholars, it is clear that there are certain statutes that impose trusts of which the Act is one of them.[51] It is not coincidence that the Act specifically used trust as the basis of the interest vested in the Governor. More so, the preamble to the Act also emphasizes the fact that the lands are vested in the Governor of the state who will hold same on trust. This shows that it was the intention of the drafters to create trust under the Act by providing for trust in the preamble and section 1 of the Act. Oluyede opined that from the preamble and section 1 of the Act, it can be gleaned

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[47] Ladan, M.T. (2006) *Introduction to Jurisprudence: Classical and Islamic*. Malthouse press Limited, Lagos, p.58.

[48] Section 4 of the Land Tenure Law of 1962; Tobi, N. (1987) *Nigerian Land Law.* Ahmadu Bello University Press Limited, pp.38-39.

[49] Tobi, N. (1987 Op. Cit. p.40.

[50] Elias, T.O. (1971) *Nigerian Land Law*. Sweet & Maxwell, London, Fourth Edition, p.27.

[51] Edwards, R. and Stockwell, N. (2002) Trusts and Equity. Pearson Education Limited, England, Fifth Edition, p.14.

that the main objective of the Act is to promote unity among Nigerians by facilitating their living together on a permanent basis.[52]

The trusteeship policy re-affirms that nobody in the state apart from the state or federal government owns land, and the power of control and management is vested in the Governor who is a trustee and manager of land in his state.[53] The trusteeship policy underlying the Act ensures that the land vested in the Governor is not for his selfish or personal interest but for the benefit of Nigerians. To that extent, the governor is to hold the land with the attendant power of control in trust for the people. The concept of trust embedded in the trusteeship policy is intended to achieve certain objectives among which are: to secure for all Nigerians right of access to land for building, industrial, commercial and agricultural purposes, to enable government unify and control the use to which land can be put in all parts of Nigeria thereby facilitating planning and development of infrastructures, to prevent land speculation and to achieve reduction in the incidences of land disputes in the country.[54] Dr. Madaki concluded that the 'trust' contemplated in section 1 of the Act implies the principles of fairness, and good faith that will ensure that the land is administered for the benefit of all Nigerians. However, there is nothing to show that the Governors have actually held land in trust for the benefit of all Nigerians.[55]

CONCLUSION

The Act was enacted to ensure that certain objectives of the Act are achieved, and address certain problems that were associated with the land tenure legislations prevailing before the enactment of the Act. One of the policies through which the Act intended to realize its objectives is the trusteeship policy by which the Governor is said to hold the land vested in him on trust for the benefit of all Nigerians. However, despite the fact that the Act regards trust as the basis of the position of Governor, it remains a controversial subject whether the Governor is a trustee in respect of the land in his territory.

This paper finds that the Act the trusteeship policy of the Act presupposes the existence of 'trust'. Thus, the Preamble to the Act and section 1 of the Act state that the land shall be held on trust, and the trusteeship policy is enshrined to ensure that the Governor does not abuse his powers under the Act, and he administers land for the benefit of all Nigerians. However, the reality is that the Governor sees himself as the owner of all land and there is no system or process in place under the Act to check the exercise of powers by the Governor.

It is therefore recommended that the Governor should observe uttermost good faith in the exercise of his powers, and he should have regard to trusteeship principles of impartiality, accountability, and honesty. More so, the Act should be amended to further entrench the

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[52] Oluyede, P.A. (1989) *Modern Nigerian Land Law.* Evans Brothers Limited, Ibadan, pp.297-298.

[53] Ibid.

[54] Madaki, A.M. (2006) "The Land Use Act Policies: An Overview". Journal of Private and Comparative Law, Department of Private Law, A.B.U., Zaria,pp.86-87

trusteeship principles to ensure that the Governor acts as a trustee of the land, and citizens should have a right to check abuse and violations of the provisions of the Act. The present situation where the Governor's powers are not fully subject to judicial review is not democratic and constitutional.

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E-Procurement Implementation in the Public Construction Sector in Nigeria: A Review

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Abstract:

E-procurement is seen as one of the essential tools that could be used by government for public procurement in an attempt to reduce the menace of corruption in the procurement processes. Anecdotal evidence has proved that about 75% of corrupt practices in Nigeria are procurement based. This study therefore, intend to explore the barriers to the implementation of e- procurement in the Nigerian construction sector using a desktop research approach. The approach provides the researcher opportunity to obtain basic information from the literature search that can serve as foundation for future research. However, it was revealed that E-procurement implementation has begun in Nigeria, but the lack of empirical research has hindered a clear framework for the adoption as expected and what is required in the public sector goes beyond the present practice. The current practices of e-procurement in the construction is at formative stage, hence more efforts are required for the implementation to yield the desire results. The paper thus concludes that unavailability of services, investment cost, technical know-how, electricity supply, internet diffusion and cyber-security are some of the factors affecting implementation of e-procurement in the country.

Keywords: Construction, E-procurement, Implementation, Nigeria, Public Sector.

INTRODUCTION

Traditionally, in the Nigerian construction industry, most construction procurement activities use paper-based system in procuring construction projects. The traditional procurement process involved paper-based advertisement, submission of tenders, and selection/award of contracts that is characterized with high cost of lithographic works and unethical practices. Country Procurement Assessment Report (CPAR) (2000), revealed that long before 1999, Nigeria lost $10 billion every year to corruption through award of contracts. Thai and Grimm (2000) found that the implementation of Electronic Procurement initiatives should be seen as an effort to improve the procurement goals, which normally include quality; timeliness; cost minimizing, business's financial and technical risks; maximizing competition; and maintaining integrity while Alam and Noor (2009) established that E- procurement has obvious benefits that include increasing transparency and accountability, standardising and monitoring, enhancing fair competition amongst bidders, avoiding human interference, reducing human errors and personal discretion in purchasing decision, and maximising value for money. According to Mahmood (2010) public procurement represents 18.42% of the world GDP; Neupane (2014) affirmed that public procurement accounts for almost 10 to 15 percent of Gross Domestic Product (GDP) in developed countries and almost 20 percent or more of GDP in developing countries. Change in the procurement process is evidently necessary not only due to the issues with traditional procurement systems but also because organisations want to meet the challenges of greater competition in the global market (Hampton et al., 2012). Neupane (2014) further saw it as an essential tool for a sincere attempt to reform the government public procurement processes as well as to reduce the chances of corruption since corruption is said to be a threat to economic and human development in all countries and is believed to be increasing at alarming rates, especially in developing countries Nigeria inclusive (Neupane, 2014).

In spite of this development and the extensive research yield going with it, there is limited understanding of the nature of technological modernisations in the use of web-based technologies in executing construction procurement undertakings (Laryea, 2014).

STATEMENT OF PROBLEM

The Nigerian government had identified the need for public procurement system that will urgently eliminate or reduce the global perception of corrupt practices and inefficiencies that have potentials to impact on good governance, and to build trust through the procurement system (BMPIU, 2005). However, E-procurement implementation has begun in the country Nigeria but e-procurement activities are actually very truncated in the country (Mundy and Musa, 2010). It can further be said that what is required to achieve a more successful procurement process in Nigeria goes beyond the present practice. In fact, Afolabi (2017) stated that construction stakeholders currently have the suitable hardware, software and other enabling settings to actively partake in the e-procurement process but Afolabi (2019) however stated that there is still need for improved wakefulness of the e-Procurement tools and technologies and the benefits that are accumulated from their usage among public sector construction participants.

E-PROCUREMENT

Chang and Wong (2010) defined E-procurement as an attempt to automate the traditional procurement system using various communication media to facilitate efficiently the process between different parties. Nawi *et al*. (2014) also stated that e-procurement is an efficient process that automates business transactions, reduces cost, improves management and brings transparency in business processes while McCormack and Johnson (2016) defined e-procurement as the use of advanced electronic technologies to develop the traditional procurement process into a more advanced one.

PUBLIC E –PROCUREMENT

Burton (2005) indicated that public E-Procurement is the core instrument that helps in economic management of public resources while Vaidya *et al*. (2006) stated that public e-procurement is an inter-authoritative data system, which automates any piece of the procurement process in order to improve efficiency, quality, and transparency in government procurement. Furthermore, Vaidya (2007) saw public electronic procurement as the use of any Internet-based Inter-organisational Information System, which automates and integrates any parts of the procurement process in order to improve efficiency and quality in procurement, and promote transparency and responsibility in the wider public sector.

PROBLEMS WITH TRADITIONAL METHOD OF PROCUREMENT

Nawi *et al*. (2014) stated that traditional procurement is work intensive and prone to errors, which are very expensive for the business in both the long and the short term. Banwo (2016), identified the problems of traditional procurement as: Very long project duration when compared to other strategies as the strategy is sequential and construction cannot commence prior to the completion of design (with no parallel working possible), there is no input into the design or planning of the project by the contractor and supplier, who will not be appointed at the design stage, the strategy is based upon price competition, which can result in adversarial

relationships developing and the client is likely to end up paying a high-risk premium where it is difficult to accurately define the full scope of the project.

IMPLEMENTATION OF E-PROCUREMENT

E-procurement has been seen as the resolution to the insufficiencies of the traditional procurement method because of the success seen to date in the private sector (Teo *et al.*, 2009; Tatsis *et al*., 2006; Muffato& Payaro, 2004). Grilo and Jardim- Gonclaves (2011) expressed that each organisation needs to accomplish the best quality procurement with the least investment, negligible risks and duplication while keeping up a competitive position and picture in the market. These successes which have been well established, indicates that there is potential for similar benefits to be realised in the public sector (Panayiotou *et al.* 2014).

However, in a study conducted by the World atlas, in spite of the rapid growth of E-readiness in most countries in the world, the Middle East and Africa currently serve a total of about 1m internet broadband subscribers, a small sum compared with the 53m in Asia and 42m in the Americas. Low levels of investment and limited sources of financing constitute the primary reasons for the slow progress. With public and private funds for infrastructure development lacking, even broadly available technologies remain too costly for widespread adoption.

Mundy and Musa (2010) stated that E-procurement implementation has begun in lower middle income countries like Nigeria but the lack of evidence and research has hindered a clear framework for the adoption as expected, in fact e-procurement activities are actually very truncated in the country Nigeria but how long will Nigeria as a country keep avoiding the implementation of e-procurement in spite of the facts that the same e- procurement have been adopted and implemented successfully to some magnitude in other parts of the world (Oseni & Dingley, 2014). It is clear that some of the sectors of the public in Nigeria are in the publish stage and a few government organisations are at the transact stage. Some organisations have even avoided the interact stage thereby giving no chance for citizen requests or feedback. It can further be said that what is required to achieve a more successful procurement process in Nigeria goes beyond the present practice of these sectors.

FACTORS AFFECTING E-PROCUREMENT IMPLEMENTATION IN NIGERIA

Many researches have established the factors affecting e-procurement implementation in Nigeria Oseni and Dingley (2014) stated that issues like awareness and availability of services and trust all need further development in order to allow e -procurement services to be delivered and used by citizens. . Aduwo *et al*. (2016) established that that the two elements with the most noteworthy challenge on the uptake of e-Procurement were the high investment cost, and absence of technical know-how required in setting up e-procurement technologies and procedures. Other factors which are evident include.

Electricity Supply

According to the reports provided by the Electricity Generating companies, the average power supply in Nigeria is 3851MW. The highest averaged power supply was fixed in January 2017 and was around 4425MW. The largest cities of the country are provided with the majority of the power and energy and there are no significant changes to this situation till date (power-Nigeria, 2019). From this, it clear that the power supply pattern in Nigeria is not enough to give room to implementation of e-procurement

Internet Diffusion

The Global State of Digital in 2019 report discovered that there are 98.39 million internet users in the country compared to January 2018, there has been a 4 million increase in the number of internet users. Despite this increase, overall internet penetration remains low, with only 50% of the population connected to the internet when compared to the global average of 57%. It was further stated that out of the 98.9 million Nigerian internet users, 54% access the internet on a daily basis while only 12 % (24 million) have active social media accounts. To improve on this, on the 2nd of April, 2019, the minister of communication, said the federal Government will ensure free access to the internet in public places across Nigeria. He further listed the challenges faced by the government in providing free internet service to include high cost of access, low broadband penetration, poor internet infrastructure and poor enabling environment (Digital, 2019).

Cyber-Crime and Cyber- Security

Although this is not peculiar to Nigeria alone, but a lot of work will need to be done to ensure that the cyber space is secured. Bharat and Abhijit (2010) stated that Security, protection and trust-related issues are basics for the successful implementation of e-procurement.

According to Frank and Odunayo (2013), Cyber-space refers to the boundless space known as the internet. It refers to the interdependent network of information technology components that underpin many of our communications technologies in place today while Cyber security is the collection of tools, policies, security concepts, security safeguards, guidelines, risk management approaches, actions, training, best practices, assurance and technologies that can be used to protect the cyber environment, organization and user's assets. Cyber security strives to ensure the realisation and preservation of the security properties of the organization and user's assets against relevant security risks in the cyber environment. However, Nigeria moved from a country with zero legislation on cyber security to a country with an extensive law with the enactment of the cybercrime (prohibition, prevention) Act ("The Act") in 2015. Despite this act, Nigeria is said to loose N127, 000,000,000 (one hundred and twenty-seven billion Naira) annually through cyber-crime (Iroegbu 2016). Osuagwu (2018) further reported that 60% of Nigerian businesses experienced cyber-attacks in the year 2018.

CONCLUSIONS

It is evident that e-procurement is the way forward in achieving an efficient and well desired procurement process in Nigeria but it has not been fully implemented. What is desired goes beyond what is presently practiced. There are a lot of impediments to the implementation of e-procurement in the country and these factors need to be looked into and curbed so that an efficient system is achieved. This paper through a review of literature, highlighted the factors affecting e-procurement implementation in Nigeria and for e-procurement to be fully implemented, availability of services, investment cost, technical know-how, electricity supply, internet diffusion and cyber-security needs to be improved upon.

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Assessement of the Prospects and Challenges of E-Procurement Practices on Construction Project Delivery in Abuja, Nigeria

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Abstract
Over the years, companies trading in the construction sector have sought to deliver quality projects and improve efficiency and effectiveness in their operations and services to stakeholders. The utilisation of e-procurement in other industrial sectors like manufacturing and retail has, for some time, been widespread, but to date is considered a relatively new phenomenon in construction. However, what e-procurement strives to achieve is far from new. This paper therefore assessed the extent to which e-procurement systems is practiced in Abuja, Nigeria, it examined the prospects of e-procurement practices and the challenges of e-procurement practices. The methodology of study involved survey approach in which 100 structured questionnaires were administered to the professionals in the construction industry. Data obtained were analysed using the frequency, percentage and mean ranking. The findings showed that E-payment is the most practiced e-procurement system by construction professionals in Abuja, Nigeria. The results of the industry survey have also identified eleven e-procurement prospects in which elimination of direct human interaction on bidding, internal efficiency increase, productivity improvement, improved effectiveness of purchasing process and reduced paperwork were top ranked. Also, e-procurement systems have technical problems, clients' lack of experience, lack of experts for system vendors and customers' lack of trust for the e-procurement systems were the top ranked challenges. The findings from the study have indicated that e-procurement systems and applications are still in their infancy stage and construction professionals are currently experiencing development issues, which can be expected with the implementation of new technologies and change initiatives. The study also recommended that organizations and Nigerian government should pay more attention to spread the knowledge about electronic procurement systems, related processes and procedures to reach new level of success toward the e-business, organizations for both public and private sectors should be responsible for the development of more efficient systems and fully integrated solutions for e-procurement and the ICT developers' companies should do more customizations for the electronic procurement integrations, especially for construction industry by integrating the systems to the related industrial systems such as BIM, and other financial systems.

Keywords: *E-procurement, E-sourcing, E-invoicing, E-purchasing, E-payment*

INTRODUCTION

Invention and adoption of new technologies and ideas increase the productivity of the business organizations, which in turn translates to economic growth. Recent technology advancements in information and communication technologies (ICT) have made a paradigm shift in the way business processes are conducted for effective delivery of projects. Electronic procurement (E-procurement) is one of the technological solutions to facilitate corporate buying. (Shukla, Khan & Shah, 2016). The number of businesses conducted electronically has reached hundreds of billions of dollars, and there is little doubt that the emergence of the internet is continually revolutionising access to communication and information (Kajewski & Weippert, 2004). The construction industry has been one of the most impacted by these radical changes. Construction industry professionals now aim at paralleling the level of use of ICT by other industries in the performance of their activities (Ibidapo, 2000)

According to Tindsley and Stephenson (2008), e-Procurement systems can address the challenges experienced in the traditional processes of procuring goods and services in the construction sector. E-Procurement systems build on the activities in the traditional procurement strategies to deliver a seamless process for the construction firm and prospective bidders (Black, Du and Nieto, 2005). Oyediran and Akintola (2011) affirmed that e-Procurement platforms increase productivity in the construction cycle while empowering

construction stakeholders to closely monitor the procurement process. In addition, their study identified the benefits of cost-saving as a result of fewer paper-based transactions and increased efficiency.

The presence of ICT in the construction industry has helped professionals to create a competitive niche in their activities compared to their traditional counterpart. Notably, the introduction of the Internet has been harnessed to solve productivity issues and bridge the supply chain of many contractors in the construction sector. In spite of this, studies from early 2000 showed that E-procurement has had low usage due to unawareness and low e-maturity of construction stakeholders (Kajewski & Weippert, 2004).

Despite previous researchers' general conclusion that e-procurement system is effective, the question is why procurement process is still based on manual activities i.e. traditional procurement system. Despite the benefits of e-procurement and the contribution to the procurement phase of a project, there are factors and challenges that affect the wide use of e-procurement. However, majority of the construction and consultancy firms are still skeptical of the potential benefits mainly due to limited human resources as regards the operation of the e-procurement process. Researchers like Afolabi et al, (2019) and Ibem et al, (2018) focused on organizational factors in their studies on e-procurement which has shown that no extensive study has been conducted on this ineffectiveness and wide use of e-procurement in the Nigerian construction industry. Therefore, there is an existing literature gap on the prospects and challenges of e-procurement practices on construction project delivery. In view of this gap, this study however assesses electronic procurement practices on construction projects in Abuja, Nigeria and therefore seeks to achieve the following objectives:

i. To assess the extent to which e-procurement systems is practiced in Abuja, Nigeria.
ii. To examine the prospects of e-procurement practices.
iii. To examine the challenges of e-procurement practices.

LITERATURE REVIEW

E-procurement

E-Procurement refers to the use of internet-based system to carry out individual or all stages of procurement process, including search, sourcing, negotiation, ordering, receipt, and post-purchase review (Croom & Brandon, 2004). Koorn et al, (2001) describes three types of e-Procurement systems which are buyer e-Procurement systems; seller e-Procurement systems; and online intermediaries.

Most organisations are primarily using e-procurement technologies to acquire noncore supplies, including office products, computer and related equipment, and maintenance, repair and operating expenses (MRO). However, Davila, Gupta and Palmer (2002) indicate a likely trend towards integrating e-procurement technologies into core business processes as more companies use them to purchase inventory, services and capital goods. Tonkin (2003) considers that e-procurement is simply those aspects of the procurement function supported by various forms of electronic communication. Its use in both the public and private sectors takes many forms including: electronic data interchange (EDI), e-MRO (maintenance, repair and operation), enterprise resource planning, web-based enterprise resource planning, e-sourcing, e-tendering, e-reverse auctioning, e-auction for disposals, e-informing and e-collaboration. However, Oughton (2005) suggests e-procurement tools broadly relate to two aspects of procurement: sourcing activity, and transactional purchasing. E-procurement can therefore be

considered as a collective term for a range of technologies that can be used to automate the internal and external processes associated with sourcing and buying (IDeA, 2004).

E-procurement has recently drawn great attention and has been adopted by an increasing number of private and public organisations. Vaiday, et al. (2002) emphasise the transparency benefits of e-procurement which can provide subsequent benefits to construction organizations. The tangible benefits of e-procurement consist of the benefits that are required to deliver enhanced shareholder value and thus gain approval, such as price savings and process cost reduction (Eakin, 2003; BuyIT, 2002). Thus, tangible benefits could be identified as reduction in purchase price and improved process efficiencies, in addition to reduction in overhead costs and process costs (BuyIT, 2002; DPWS, 2002; IDeA, 2004; Turban et al, 2004; Chaffey, 2004). Coupled with these benefits includes intangibles such as improved information, communication, collaboration and knowledge management, in addition to improved commercial relationships with suppliers and high visibility of suppliers' performance (BuyIT, 2002; DPWS, 2002; IDeA, 2004; Chatterjee, 2005).

However, there are many identified barriers that make construction organisations fear the adoption of e-procurement solutions, and different construction organisations may consider different issues as the reasons not to embrace the technology. In essence, barriers can be identified as technical barriers, market barriers and organisational barriers.

Aduwo *et al.* (2016) identified the barriers that reduce the use of e-Procurement systems in the Nigerian environment as majorly cost of providing the physical infrastructure and skill to run it. The study further identified the predictors of low uptake of e-Procurement by construction stakeholders.

In the study by Ibem *et al.* (2018), the digital technologies that aid the use of e-Procurement systems in the Nigerian construction industry were identified. The digital technologies mostly used were emails by construction stakeholders rather than a custom or third-party web-based/cloud procurement system. Their study argued that there are critical factors that spur the choice of digital technologies implemented in the e-Procurement process. The authors noted that construction stakeholders adopted e-Procurement technologies due to its ability to eliminate location barrier of procurement participants, increased efficiency, improved procurement data management, and improved transfer of information during the procurement process.

In Kenya, Obat (2016) identified key areas of Internet, supplier, and change as strategic points for e-Procurement integration in the construction sector. He argued that the Internet services must be reliable and suppliers must be integrated in the e-Procurement process. In addition, a proper change management plan should be drawn up while moving from the traditional to ICT-based tools. The study by Afolabi, A. *et al* (2019) revealed that construction stakeholders perceived the availability of reliable, affordable, and fast Internet services as the most critical success factors for the adoption of e-Procurement technologies. The critical success factors (CSFs) were further classified into management support for physical infrastructure, and human factors and characteristics of the technology. The study showed that these critical success factors (CSFs) are crucial for the adoption of e-Procurement systems in the Nigerian construction industry. From the aforementioned studies, there are few studies that have concentrated on developing countries in sub-Saharan Africa such as Nigeria. More of them have been focused on organizational factors. Therefore, there is an existing literature gap on the prospects and challenges of e-procurement practices on construction project delivery.

RESEARCH METHODOLOGY

This study used a descriptive research design to assess the prospects and challenges of E-Procurement practices on construction project delivery in Abuja, Nigeria. The design seeks to describe the extent of e-procurement systems (e-sourcing, e-invoicing, e-purchasing and e-payment) adopted in the industry and examine the prospects and challenges of e-procurement practices on the delivery of construction projects. 100 Questionnaires were designed and administered with the objectives of assessing e-procurement practices adoption, prospects and challenges on construction project delivery using Abuja as a case study.

The targeted population for this study involved all the construction professionals; architects, builders, construction/project managers, procurement/supply chain managers, quantity surveyors and engineers in Abuja, Nigeria. Data obtained were analysed using the frequency, percentage and mean ranking.

RESULTS AND DISCUSSIONS

Background Data of Respondents

Result in Table 1 shows the background data of respondents. It shows that there are more male construction workers than the female construction workers in Abuja due to the nature of the work being carried out there.

Table 1: Background Data of Respondents

	Categories	Frequency	Percentage (%)
Gender	Male	63	75.0
	Female	21	25.0
	Total	**84**	**100.0**
Age	25 -29	36	42.9
	30 – 34	21	25.0
	35 – 39	15	17.9
	40 – above	12	14.3
	Total	**84**	**100**
Education	OND/NCE	22	26.2
	HND/B.Sc.	48	57.1
	M.Sc./MEng/M.Tech	12	14.3
	PhD	2	2.4
	Total	**84**	**100**
Profession	Architect	19	22.6
	Quantity Surveyor	21	25.0
	Procurement/Supply chain Manager	7	8.3
	Builder	12	14.3
	Engineer	17	20.2
	Construction/Project Manager	8	9.5
	Total	**84**	**100**
Management Level	Lower	51	60.7
	Middle	25	29.8
	Top	8	9.5
	Total	**84**	**100**
Experience	1 – 5	31	36.9
	6 – 10	26	31.0
	11 – 15	14	16.7
	Above 15 years	13	5.5
	Total	**84**	**100**

Majority of respondents were at least university graduates. The most represented professionals are the Quantity Surveyors and Procurement/Supply chain Managers. The data in the table implies that the respondents were well equipped both academically and professionally to give reasonable insight to the questions of this research.

Extent of E-procurement Systems Practiced on Construction Projects

In analysing the extent at which e-procurement systems are frequently used on construction projects within the state, a list of e-procurement systems was provided and the respondents were asked to indicate the extent to which the systems have been integrated into the procurement function of their projects using a scale of 1-5, where (1-Not at all, 2-small extent, 3-moderate extent, 4-large extent and 5- very large extent) as shown in Table 2. The result reveals that for the adoption of e-sourcing, majority of the respondents practice e-tendering and e-auctioning to a moderate extent. For the adoption of e-invoicing, majority of the respondent practice e-invoicing to a moderate level. For e-purchasing, majority do not practice e-purchasing, e-marketplace and supplier website. Most of them practice e-payment; and others practice Internet mobile payment, credit and debit cards to a very large extent. Overall, it can be seen that e-procurement systems have considerable amount of usage in the delivery of construction projects in Abuja, Nigeria. However, the system mostly used to a very large extent is the e-payment and the least is the e-purchasing.

Table 2: Extent of E-procurement systems practiced on construction projects

	E-Sourcing	1	2	3	4	5
1	E-Tendering	9	6	29	19	21
2	E-Auctioning	1	11	34	21	17
	E-Invoicing					
3	E-Invoicing	5	10	37	20	12
	E-Purchasing					
4	E-Purchasing	45	4	11	15	9
5	E-Marketplace	46	5	20	10	3
6	Supplier Websites	33	9	12	23	7
	E-Payment					
7	Internet Mobile Payments	3	11	15	20	35
8	Credit and Debit cards	6	14	21	14	29

Prospects of E-Procurement Systems

Table 3 focuses on the prospects or qualitative benefits that accrue from adopting E-procurement in Abuja, Nigeria. These benefits are expected to accelerate the rate of adoption of e-procurement once the uncertainties that remain are reduced to levels that encourage significant resource commitments.

In determining these, a list of factors identified from literatures was provided which the respondents were to rate based on their level of significance. The table shows the ranking of the factors and their mean values.

From the table it can be seen that E-procurement eliminates the direct human interaction on bidding, and internal efficiency increase, Productivity and/or service improvement, improved effectiveness of purchasing process and reduced paperwork are the top ranked factors with an overall mean weighted point of 3.99, 3.98, 3.98 and 3.95 respectively. The least ranked is Reduced order cycle times with a mean point of 3.57.

This generally implies that the elimination of direct human interaction on bidding, internal efficiency increase, productivity improvement, improved effectiveness of purchasing process and reduced paperwork are the major prospects of e-procurement in Abuja, Nigeria.

Table 3: Prospects of E-procurement Systems

	Prospects of E-procurement systems	**1**	**2**	**3**	**4**	**5**	**Mean Weighted Point**	**Rank**
1	Reduce order cycle times	7	10	13	36	18	3.57	11
2	Expand supplier bases	8	9	17	19	31	3.67	9
3	Reduce paperwork	3	10	15	16	40	3.95	4
4	Eliminate order errors	6	8	10	22	38	3.93	5
5	Inventory reduction	2	16	18	27	21	3.58	10
6	Productivity and/or service improvement	4	9	11	21	39	3.98	2
7	Decrease prices, price advantages	6	9	13	21	35	3.83	6
8	Improved communication and collaboration with suppliers	2	15	19	20	28	3.68	8
9	Improved planning and control	10	4	14	19	37	3.82	7
10	Improved effectiveness of purchasing process	5	7	12	21	39	3.98	2
11	E-procurement eliminates the direct human interaction on bidding, and internal efficiency increase.	3	10	12	20	40	3.99	1

Challenges of E-procurement systems

Table 4 shows the challenges that respondents face with e-procurement implementation on their projects. The table shows the ranking of the factors identified from literatures and their mean values. From the table it can be seen that E-procurement systems having technical problems, Clients' lack of experience, Lack of experts for system vendors and Customers' lack of trust for the e-procurement systems are the top ranked factors with an overall mean weighted point of 3.99, 3.85, 3.82 and 3.82 respectively.

Table 4: Challenges of e-procurement systems

	Challenges of E-procurement systems	**1**	**2**	**3**	**4**	**5**	**Mean Weighted Point**	**Rank**
1	No support from Government	10	11	16	23	24	3.48	11
2	Infrastructure problems for implementing E-procurement	8	6	12	26	32	3.81	5
3	Clients' lack of experience	6	9	13	20	36	3.85	2
4	No clear strategy for e-procurement business	7	10	14	33	20	3.58	9
5	Lack of experts for system vendors	10	4	14	19	37	3.82	3
6	Expensive good quality e-procurement	7	11	13	22	31	3.70	7
7	Corruption from customers	10	11	17	21	25	3.48	11
8	Customers' lack of trust for the e-procurement systems	7	8	11	25	33	3.82	3
9	Material suppliers not qualified for e-procurement	9	7	10	27	31	3.76	6
10	Contracting not transparent in e-procurement system	7	9	26	12	30	3.58	9
11	No quality control for the e-procurement systems	8	9	14	22	31	3.70	7
12	E-procurement systems having technical problems	4	8	12	21	39	3.99	1

The least ranked is No support from government with a mean point of 3.56. This generally implies that the major challenges construction professionals face with e-procurement systems on construction project delivery are technical problems experienced with the systems, clients'

lack of experience, lack of expert system vendors and lack of trust for the e-procurement systems.

The study found out that E-payment is the most practiced e-procurement system by construction professionals in Abuja, Nigeria. The results of the industry survey have also identified eleven (11) e-procurement prospects in which elimination of direct human interaction on bidding, internal efficiency increase, productivity improvement, improved effectiveness of purchasing process and reduced paperwork were top ranked. Additionally, E-procurement systems having technical problems, clients' lack of experience, lack of experts for system vendors and customers' lack of trust for the e-procurement systems were the top ranked challenges out of the twelve (12) identified. It is believed that the findings of this study will encourage a wider adoption of the various e-procurement systems in Abuja and across Nigeria as well towards achieving successful construction project implementation.

CONCLUSION

This study was carried out to assess the prospects and challenges of e-procurement practices on construction project delivery in Abuja, Nigeria. The findings from the study have indicated that e-procurement systems and applications are still in their infancy stage and construction professionals are currently experiencing development issues, which can be expected with the implementation of new technologies and change initiatives.

RECOMMENDATIONS

In view of the research findings and conclusions drawn from the study, the following recommendations are made.

- Organizations and Nigerian government should pay more attentions to spread the knowledge about electronic procurement systems, related processes and procedures to reach new level of success toward the e-business.
- It is the responsibility of organizations for both public and private sectors to develop more efficient systems and fully integrated solutions for e-procurement.
- The ICT developers' companies are required to do more customizations for the electronic procurement integrations, especially for construction industry by integrating the systems to the related industrial systems such as BIM, and other financial systems.

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An Assessment of Users' Satisfaction with the Adequacy of Security Measures in Mixed-use Buildings in Abuja

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Abstract:

The question of security of life and property has been a global concern since time immemorial with terrorism, insurgency and crime being some the most prominent threats to life and property. Nigeria as a nation has not been left out of this global issue. In recent times different parts of the country, including the Federal Capital Territory (FCT) Abuja, have come under severe attacks which have led to the loss of lives and property. This has made it necessary for every stakeholder- including the built environment professionals - to make necessary contributions to the security of life and property. Sustainable passive and active security measures need to be put in place in order for the built environment to be adequately braced up to mitigate security challenges. Passive security incorporates design techniques and elements that have been deliberately put in place to mitigate or avert the effects of security threats to the built environment. This research aims at assessing the adequacy of security measures in mixed-use buildings in Abuja, from the users' perspective. This was done via post occupancy evaluation with the aid of questionnaires, the data was analyzed and from the results it was discovered that users were relatively satisfied with the current level of security.

Keywords: User Satisfaction, Security, Mixed-use Building, Post-occupancy Evaluation

INTRODUCTION

Mixed-use buildings are a common thread in the fabric of a city and are concomitant to urbanization and population explosion in modern cities. The ubiquity of this typology in cities is borne of its inherent ability to combine commercial and residential programs, thus becoming an efficiency-based space-saving medium as well maximising economic returns from the finite resource which is Land.

In Abuja, the capital city of Nigeria, the mixed-use building typology is clustered around its financial and administrative core in areas such as Central area, Maitama, Wuse and Garki, while new developments are rising and can be found in the bordering, residential corridors of Kado, Mabushi, Katampe and Asokoro all varying heights and inherent commercial functions. In recent times, there is a growing and noticeable trend of insecurity in the city as there is a surge in occurrences of criminal incidences (Bello, 2019). The prevalence of this incidences is unlike the strategic nature of previous insurgency attacks when the city was bombed a few times by the notorious Boko-haram sect, this new wave instead seems to randomly target both high net worth individuals as well as common residents of the city many of either reside, transact or work in the many mixed-use buildings around the core of the city.

This situation has led to the administration of the city embarking on many post-meditated measures taken to combat the crisis such as increased police presence in the city's neighbourhoods, closing down of entertainment and nightlife centres where city officials believe crime is being festered, the ban and restriction of bi-pedal and tri-pedal means of transportation such as *Keke* and *Okada* throughout the larger parts of the city save the inner roads and undeveloped corridors.

This then prompts a transparent, quantitative study of user satisfaction of the users and managers of these facilities with the security measures pre-designed into these buildings they occupy and if they believe they are sufficient.

LITERATURE REVIEW

Concept of CPTED (Crime Protection through Environmental Design)

CPTED operates on the belief that through the incidence of crime can be reduced through proper design and effective use of the built environment. CPTED is geared towards reducing the chances of criminal activities occurring within built spaces. In applying the principles of CPTED, it is necessary to determine the purpose for which a space is intended, how such space is defined and how well such design fits its intended function.

There are four underlying principles to the application of crime protection through environmental design;

i. Natural surveillance
ii. Natural Access Control
iii. Territorial Reinforcement
iv. Target hardening

Natural Surveillance

Natural surveillance is a design CPTED strategy geared towards ensuring intruders are kept under observation. It gives room for legitimate users of a facility to observe the space while going about their normal activities. Natural surveillance involves physically positioning a building and activities in a manner that maximizes natural visibility and observation (North Yorkshire police, 2014). Offenders/defaulters are constantly given the impression of being watched thus discouraging the perpetuation of crimes (Virginia police department, 2011). Glazing, proper selection and placement of carefully selected plants could be considered in maximizing the impact and resultant effects of natural surveillance.

Natural Access Control

This is a design strategy that seeks to decrease crime opportunity by denying access to a crime target and creating an impression/perception of risk to an offender. Features such as bollards, paved walk ways, and reinforced planters are used to deny offenders access to these targets, reduce escape opportunities and also serve as a guide for legitimate users of a facility.

Territorial Reinforcement

Territoriality is a concept that is intended to clearly mark out a space as public, semi-public or private and indicate appropriate ownership of such space. Territoriality fosters a behavior which challenges unwanted acts or abuse that may occur within such space. It creates an environment where strangers and possible intruders stand out and are easily identified. Territoriality also encompasses natural surveillance and access control.

Target Hardening

Target hardening consists of measures taken to make targets more resilient to attacks. Elements capable of slowing down intruders or increasing the chances of such being detected are employed to make this effective. Employing good target hardening strategies therefore, increases the chances of intruders being spotted and decreases the time it takes to gain access into a building. The more time spent in committing an offence, the higher the vulnerability of the offender (North Yorkshire, 2014).

Physical Security Design

Physical security involves the installation of environmental structures such as walls, fences, barbed wires, vehicle barriers and speed bumps which either prevent or stop an attack from

occurring (Elert and associates, 2013). Other physical security measures that can be implemented in design include limiting the number of entrances into the building, directing movement through the building's design to ensure movement through the various checkpoints provided and reinforcing the building envelope with steel or concrete to ensure it withstands diverse forms of attack.
Physical security adopts four (4) basic principles. These are;

I. The use of layered defense systems
II. The use of barriers
III. Segregation
IV. Minimizing the number of users

Layered Defense System
This involves setting out multiple defense mechanisms such that if one fails, another will be in place to sustain the line of defense against threats. This reduces drastically the vulnerability of an asset to an attack.

Barriers
Barriers should always be used as a primary defense mechanism against attacks in place of other forms of security control measures (Clarke, 2009). With a pre-established strength, a good barrier should be capable of preventing attackers from gaining entry into a building.

Segregation
This entails designing such that if one segment of the building comes under attack, only the attacked segment is affected. Other segments of the building are still able to function without the part that is under attack.

Minimization of the Number of Users
Reducing the number of people with access to the building because the more the number of people who can access the building, the higher the risk of the building coming under attack.

Passive Security
Passive security is an aspect of physical security that concerns itself with the integration of security measures and elements in the architecture and landscape of a building and its site's design. Passive security involves the implementation of measures which prevent unauthorized access to personnel, installations, equipment and also protect these against acts of terrorism and criminal activity (physical security program, 2007).
It is impossible to completely eliminate all risks; a good security design balances security design implementation with the likelihood of the occurrence of an attack in a prioritized approach which results in the acceptance of a conscious and acceptable level of risk (NIBS, 2014). Different buildings providing varying functions require different levels of security depending on the service such facilities provide. Site planning and building elements are easily adjusted in the design stage than in the later phase when major changes or additions will incur extra cost (Nadel, *et al,* 2001).

Passive Security Measures
These define the various means through which passive security design is incorporated into architecture. It essentially entails incorporation of CPTED concepts which cover architecture, lighting and landscape and boost security by deterring potential threats (Smith, 2012).
Some of these measures include;

i. Making provision for adequate setbacks and stand-off distances
ii. Carefully planning the building's layout and orientation to minimize the effects of forceful intrusions.
iii. Employing the use of physical barriers such as bollards, reinforced planters and other site furnishings that can withstand impacts from on-coming threats.
iv. Positioning parking spaces far away from the main building to minimize blast impacts from potential vehicular borne threats and ensuring basement parking is discouraged in design.

The use of one of the above strategies can be effective but a combination of two or more provides a more reliable solution.
The following variables were established from literature and were used in the preparation of questionnaires that were administered to determine the level of user satisfaction with current security measures.

1. Natural surveillance
2. Natural Access Control
3. Territorial Reinforcement
4. Target hardening
5. The use of layered defense systems
6. The use of barriers
7. Segregation
8. Minimizing the number of users

RESEARCH METHODOLOGY

This study adopts qualitative research method. This was used to achieve as Post-Occupancy Evaluation (POE). This will be achieved using a questionnaire. Adedeji & Fadamiro (2012) provide a basis for the use of a Post-Occupancy Evaluation (POE) method. The use of a POE is accepted generally in the built environment for obtaining opinion of users and in observation studies which tests both general and specific aspects of planning and detailed design of buildings or facilities of various typologies.
The study population covers the residential and commercial environments of various mixed-use buildings in Abuja, Nigeria. Data for this study would be generated by means of a structured questionnaire administered on a systematic sample of 100 respondents from 10 mix-used buildings, from a sampling frame of 50 buildings. Established variables would be employed in the survey administered to these occupants of selected mixed-use buildings in Abuja. The performance criteria developed will be used in evaluating the security characteristics of mixed-use buildings. The data would be analysed using descriptive and inferential statistics.

RESULTS AND DISCUSSION

After the data was analyzed, the following results were obtained
Number of questionnaires administered: 100
The variables established in the literature review were given codes as seen in Table 1 to enable them to be properly analyzed, a scale of 1-5 was used to judge the level of satisfaction among users of mixed-use facilities and they are defined in Table 2.

Table 1: coding of variables

VARIABLES	CODES
Natural surveillance	NS
Natural Access Control	NA
Territorial Reinforcement	TR
Target hardening	TH
The use of layered defence systems	L
The use of barriers	B
Segregation	S
Minimizing the number of users	U

Table 2: definition of frequency

Number	Interpretation
1	Inadequate
2	Fairly Adequate
3	Undecided
4	Adequate
5	Very adequate

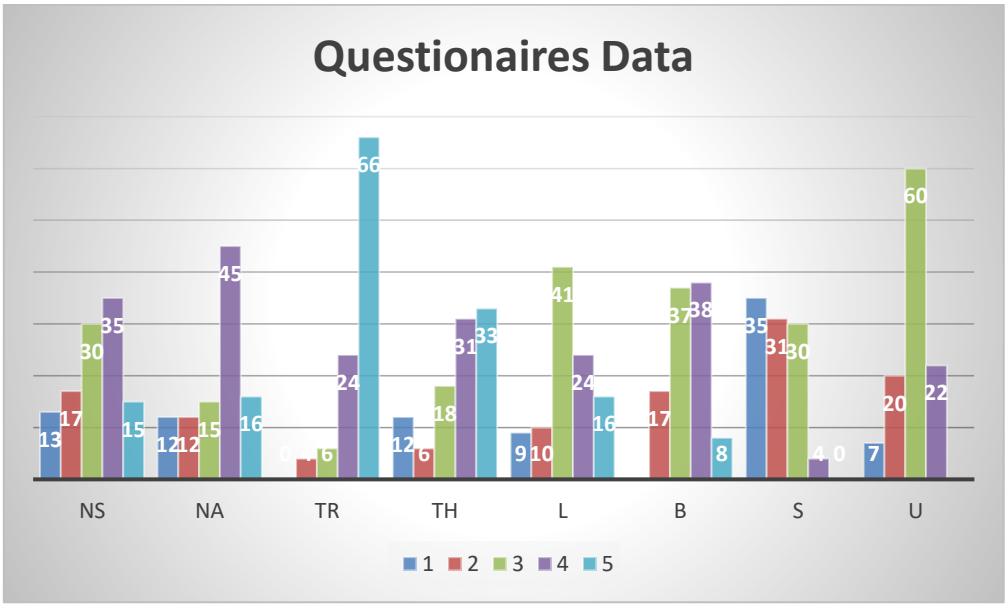

Figure 1: data generated from questionnaires

FINDINGS

Natural surveillance is generally adequate among mixed used buildings in Abuja, with 35% of the sample size agreeing that, the level of natural surveillance in their buildings is adequate however, as seen in Figure 1, a combination of 60% of the sample differ on that opinion with 30% being indifferent.

There is restricted access to non-users of the facilities in majority of the buildings, 61% of the sample corroborate this, meaning it is rare for non-tenants to have unrestricted access to buildings and however there are public parts of the buildings that may be continuously open to them.

Users are generally satisfied with the level of reinforcement in the facilities that enable them spot intruders easily. As shown in Figure 1, 90% of the sample reside in buildings that are reinforced. With the use of segregation and layered defense practiced in most buildings it seems it is the logical way to ensure the safety of the occupants as 82% of Users are generally unsure if the number of users that have access to the buildings can be regulated.

CONCLUSIONS

The study shows that a majority of the mixed-use buildings in Abuja incorporate some form of passive security measures and the users of the buildings are generally satisfied with it, although there can be improvement to the features and their intensity. The use of active security measures is as important as the passive measures incorporated in buildings while they are being constructed. Restriction of non-users into buildings may not be 100% possible but with concepts such as target hardening, layered defences and territorial reinforcement being practiced, it is possible to curb potential crime in buildings.

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Allocation of Emerging Risks of E-Communication in Public Private Partnership Projects in Nigeria

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Abstract:
The use of various forms of Public Private Partnerships (PPPs) in delivering public infrastructures has been increasing. There are several researches on PPP and e-communication, and the risks associated with them. However, previous studies on e-communications in PPP projects has shown that there are emerging risks but have failed to clearly allocate these risks factors to various parties in PPP projects. This paper assesses the risk allocation preference for emerging e-communication risks in PPP projects as that will assist in completing the risk management framework. Data was collected using questionnaires. Respondents' preferences of allocation between the public and private sectors were established. Construction professionals are the respondents. A sample frame of 2,287 was obtained and a sample size of 329 was determined. Data was analysed using descriptive statistics. The respondents risk allocation preferences showed that eleven (11) risk factors (which include: Failure of the system of communication used, problems of coding and decoding by sender and recipient, Overhasty, ill-considered and unclear messages generated) could be shared between the public sector and the private sector and eight (8) (which include: Using substandard gadgets, tempering or copying of company's websites, risk of creating libel) risk factors are assigned to the private sector as none of the risk factors are assigned to the public sector alone. The study concluded that risks are best shared between parties.

Keywords: Public Private Partnership, E-communication, Risk allocation, Nigeria

INTRODUCTION

Historically, most governments and their agencies have commonly funded public infrastructure projects either directly from budgetary allocations or by raising loans secured against government guarantees. Public Private Partnerships (PPPs) were introduced as a result of the inability and incapability of governments to provide public infrastructure to the public on its own. It therefore joins forces with a private entity (Akintoye, 2006: Li *et al., 2005*).

There are several models of PPP some of which includes; Private Finance Initiative, Joint ventures, Financially Free-standing Projects, Classic PFI, Build Operate Transfer (BOT), Build-Operate-Own (BOO), Build, Transfer Operate (BTO),Build-Lease-Transfer (BLT), Build Rent Transfer (BRT), Design Construct Manage and Finance (DCMF). **(**Midala, 2009; Ilia, 2010).

Evidences from around the world show that delivery mechanisms for PPPs vary and cover a diverse range of approaches through which services and/or facilities for public use are procured by practices such as Build Operate Transfer (BOT), Joint Ventures (JV) and Build Own Operate (BOO) which were traditionally not PPPs have now evolved to involve some of the core feature of PPPs such as shared authority and responsibility, joint investment, sharing liability/risk taking and mutual benefit and are now accordingly considered as PPPs (Ibrahim *et al*, 2006).

There are several issues about PPP which include, concessionaire selection; success factors; tendering and negotiations; conditions of PPP; risk issues; value for money; etc. amongst these risk issues is the risk of E-communication., Emerging risks in e-communication are those risks that are becoming known as a result of examination and questioning of such means of communication. Several factors affect the contract negotiation by the public sector client for PPP projects. These factors include open/frank and flexible communication during negotiation, top level commitment, etc. Risk Management is important in executing a PPP project in other

to maximize value for money and risk response techniques are inexhaustible. The most important PPP risk factors are unproven Engineering Techniques, availability of finance/corruption and lack of respect for law (Midala, 2009; Ibrahim, 2010). Gaude (2011) investigated emerging risks of e-communication in PPP projects and found that ecommunication is widely embraced in PPP projects in Nigeria because of its ease, fastness and low cost is less costly.

Electronic communication (E-communication) is a system used as means of sending or retrieving messages through computer or Internet connections. Currently, these include a multitude of communication tools, ranging from simple forms such as e-mails to more complex forms like electronic document management (EDM) systems, enterprise resource planning (erp) systems and project planning systems. The introduction of different e-communication tools may alter firms' operations, providing firms with innovate venues for impacting their management processes (Gaude, 2011). Despite the researches that has been carried out on e-communication there seems to be no work on the allocation of these emerging risks of e-communication in PPP projects.

The aim of this paper is to determine the risk allocation preference for emerging risks factors in PPP projects via the objectives of first finding out the emerging risks of e-communication, parties to PPP arrangement, allocation methods in PPP and then shared according to the allocation preference best selected by respondents.

REVIEW OF RELATED STUDIES

Akintoye (2006) defined PPP as "contractual agreement of shared ownership between a public agency and a private company, whereby they pool resources together and share risks and rewards, to create efficiency in the production and provision of public or private goods. The concept of Public Private Partnership is underpinned by a government's desire to resolve financial constraints by joining forces with the private sector to increase efficiency and effectiveness in the delivery of public services and facilities, whilst ensuring better risk management and increasing certainty of outcomes (Akintoye, 2006; li *et al., 2005*)

Gaude (2011) found that the risk involved in communicating electronically is the problem of distortion, failure of the system, use of substandard gadget by the parties and the problem of coding and decoding. Therefore, the highest ranked, which is distortion, has the highest risk. Distortion could cause lots of mishaps in a project communication.

Other risks are outlined by Zhang (2003) include risk of creating a binding contract by one party not intended by the other, risk of creating libel, reconstitution of emails, dissemination of personal materials, and presence of destructive viruses. Other risks include tampering/copying of company's website, accessing internet at work for private purpose, and harassment/bullying.

At the start of a typical PPP contract procurement process, the public client normally provides a risk allocation scheme to the contractor along with the tender documents (Li *et al,* 2005). Three common methods of risk allocation include a list of risk factors, a risk matrix and a risk allocation frame work. Since transparency in the procurement process is regarded as a critical success factor of the PPP projects, it is important that risk allocation is clearly communicated and understood between partners (Ibrahim *et al.* 2006).

Ibrahim *et al* (2006) identified Sixty-one PPP risk factors from literature and classified into exogenous and endogenous risks and found that the three most important PPP risk factors in Nigeria are "unstable government", "inadequate experience in PPP" and "availability of finance". Also, the respondents' risk allocation preferences of the research showed that while

most of the endogenous risk factors could be assigned to the private sector partner, the public sector should retain political and site acquisition risks, while relationship-based risks should be shared between the private and public sector partners. Too often, risks are under estimated and allocated to parties without the knowledge, resources and capabilities to manage them effectively (Martin and Loosemore, 2007). More risks are allocated to contractors or shared between contractors and owners with only two risks allocated directly to the owners (Sameh, 2008). Li *et al* (2005) reported that the final risk allocation agreement is reached along with overall contract agreement. It is important for the public client and the private bidders to assess all the potential risks through the whole project life. Some risks should still be retained within the public sector or shared with the private sector. These are mainly *macro* and *micro* level risks. The majority of risks in PPP/PFI projects, especially those in the *meso* level risk group, should be allocated to the private sector. However, there are a few risks where unilateral allocation is not always obvious. Peckiene *et al* (2013) citing Bing *et al* identify four categories of risk allocation, namely, (1) risk should be allocated to the public sector; (2) risk should be allocated to the private sector; (3) risk should be shared between the public and private sectors; and (4) risk allocation is highly dependent on individual circumstances of a project (when risk cannot be allocated to any of the aforementioned three categories).

RESEARCH METHOD

The research approach adopted was quantitative. Nineteen (19) emerging risks of e-communication were identified from extant literature.

The questionnaire was used to collect data for the allocation of risks of e-communication in PPP projects. The questionnaire consisted of two sections: section A contained background information, and section B the risk allocation preferences. The population considered is the construction professionals. As there is no any database of organizations involved in PPP projects in Nigeria (probably because the procurement method is still at formative stage). The construction professionals include registered contractors and consultants mainly (Architects, Quantity Surveyors and Engineers) based in Kaduna State. Consultants, contractors, clients and academics that are either involved or have experience in PPP were considered as the sampling frame. Convenience sampling was the technique used. This technique was adopted because of the nature of the study, and similar studies like Li et al (2005) and Ibrahim et al (2006) have adopted same technique. Sample frame of 2,287 respondents; 2,216-contractors, and 71-consultants adopted (Abubakar, 2014). Sample size of **329** was determined by Krejcie & Morgan (1970) formula.

Descriptive statistics were used to analyse the data collected. Frequencies were used to get the best response strategies. However, the risk allocation preferences were analysed using percentages.

Percentage distribution was used for background information. The preferred risk allocation options are presented as percentages of total counts of responses. The criteria used for allocation is the popularity of opinions (in this case, greater than 50%) is the criteria used for allocation. For interpretation purpose, a risk is allocated to the party that over 50% of the respondents are in favour of. Within the above categorization, response frequencies above 75% are regarded as "sole allocation" whereas response frequencies between 50% and 75% are regarded as "primary allocation". On the other hand, if none of the frequencies for any risk factor is up to 50%, the risk is regarded as being "dependent on individual project circumstances" (Ibrahim *et al*.,2006).

RESULTS AND DISCUSSIONS

Table 1 shows that 28 responses of the respondents which is equivalent to 56% are working in a consultancy firm this shows that their responses are reliable because they are involved even at the decision-making stage of the contractual arrangement. 20 of the respondents which represents 44% are Architects, 20 which is 40% are Quantity Surveyors while the remaining 8 responses of 16% are from structural Engineer.70% of these responses are from top management, while the rest from middle and lower management, their responses are overwhelming and reliable sine its coming from the people with authority and experience. 12 of the respondents which represent 24% from the above table have 1-10 years of experience. 44% have a working experience of 11-20 years, 32% have a working experience of 21-30 years. Highest percentage of responses are coming from respondent with 11-20 years of experience; thus, the responses are reliable since years of experience determine reliability of responses. 92% are frequently involved in Public Private Partnership Projects, 4 of the respondents which is 8% answered that their involvement in the concession is not frequent. This shows that greater numbers of the respondents are into concession arrangement. Hence, that shows that responses came from the right people who are involved in the subject matter, 82% are from private organization while 18% from public sector. Since most of the respondents are from the private sector, which gives a fear response because the private sector builds the infrastructure and is aware of all the risks.

Table 1: Responses to Questions on the Feild

Background Information of Respondents			
Variables	Categories	Frequency	Percent
Organization of Respondents	Consultancy	28	56
	Contracting	22	44
Discipline	Architect	22	44
	Quantity Surveyor	20	40
	Structural Engineer	08	16
Position	Top management	35	70
	Middle management	12	24
	Lower management	03	06
Years of Experience	1-10 years	12	24
	11-20 years	22	44
	21-30 years	16	32
Frequency of involvement in PPP	Yes	46	92
Projects	No	04	08
Role in the concession	Public	09	82
Arrangement	Private	41	82
PPP project type involved by the	Housing and offices	28	56
Respondents	Civil Engr.works	20	40
	IT & Telecom.	02	04
PPP model	BOT	28	56
	JV	16	32
	BOOT	06	12

The respondents are more into PPP projects of constructing houses and offices with 28 respondents (56%), followed by civil engineering works with 20 respondents (40%), then IT and telecommunications (4%). Housing and offices construction hence is seen to be the most

popular type of concession among the respondents. BOT having 28 respondents with 56% is the highest form of PPP followed by JV with 32%, then BOOT 12%.

Risks that should be allocated to the Private Sector Partner

Table 1 indicate that the respondents prefer to allocate the identified PPP risk factors to the private sector partner. Out of the 19 risk factors, the survey respondents indicated that 8 (representing 42.1%) should be assigned to the private sector partner. Of these, five risk factors are preferably assigned to the private sector partner (Figure4.1 frequencies between 50% and 75%) and these include ' Using substandard gadgets, tempering or copying of company's websites, risk of creating libel, relationship between main contractor and subcontractor, relationship between contractor and consulting team, viruses contained in external emails are capable of affecting recipients computer, claims for harassment and discrimination by employers as a result of using the internet to access illegal sites, potential liability of the company as a result of harassment, discrimination and bullying, these risk factors were preferably assigned primarily to the private sector partner. Consequently, since substantial amount of the risks associated with PPPs have been allocated to the private sector, the selection of the private sector partner with the necessary skills, experience and resources to manage the risks and yet deliver quality and cost-effective facilities and services is very crucial to the success of PPP projects, and thus require further investigation.

Risks that should be shared between the Public and Private Sector Partners

Table 2 also show that eleven (11) risk factors which translates to (57.9%) should be preferably shared between the public and private sector partners.

Table 2: Respondents Perception on Risk Allocation

Factor	Allocation/Percentage of Respondents				
	public	**private**	**shared**	**TOTAL**	**DECISION**
Using substandard gadgets	16	**66**	18	100	PRIVATE
Tempering or copying of company's website	10	**70**	20	100	PRIVATE
Risk of creating label	8	**74**	18	100	PRIVATE
Relationship between main contractor and subcontractor	18	**58**	24	100	PRIVATE
Relationship between contractor and consulting team	8	**70**	22	100	PRIVATE
Viruses contained on external e-mails is capable of affecting recipient's computer	10	**64**	26	100	PRIVATE
Claims for harassment and discrimination by employers as a result of using the internet to access illegal sites	10	**74**	16	100	PRIVATE
Potential liability of company as a result of harassment, discrimination and bullying	20	**58**	22	100	PRIVATE
Distortion of the channel	10	20	**70**	100	SHARED
Dissemination of personal material i.e. valuable messages can be dumped in unwanted e-communication	12	30	**58**	100	SHARED
Overhasty, ill-considered and rude unclear messages generated	18	12	**70**	100	SHARED
Risk of creating a binding contract by one not intended by the other	20	18	**62**	100	SHARED
Ability to generate instant responses	4	18	**78**	100	SHARED
Poor communication against parties	12	24	**64**	100	SHARED
Relationship between contractors and owner	14	30	**56**	100	SHARED
Increased duration of the project due to misunderstanding through communication	14	20	**66**	100	SHARED
Insecurity of the system or channel of communication	10	16	**74**	100	SHARED
Failure of the system of communication used	12	18	**70**	100	SHARED
Problems of coding and decoding by sender and recipient	2	10	**88**	100	SHARED

They are: Failure of the system of communication used, problems of coding and decoding by sender and recipient Overhasty, ill-considered and rude or unclear messages generated , Risk

of creating a binding contract by one not intended by the other , Ability to generate instant responses, Poor communication against parties, Distortion of the channel, Dissemination of personal material i.e., valuable messages can be dumped in unwanted e-communications, Relationship between contractor and owner, Increased duration of the project due to misunderstanding through communication and Insecurity of the system or channel of communication. This strengthens the perception that harmonious and collaborative working relationships are very vital to the success of long -term PPP projects (Li *et al*, 2005)

CONCLUSIONS

The paper has demonstrated that in the process of providing public infrastructures through PPP comes some risks of e-communication, and this risk needs to be allocated fairly amongst the parties involved. It's better for the parties to reach a mutually acceptable risk allocation scheme, at the inception of the project that will ensure value for money. It is recommended that research be carried out on how the allocated risks could be managed by the parties.

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Mechanism for Building Standards: Towards an Effective Building Control Practice in the Federal Capital Territory (FCT), Abuja

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Abstract:

Despite the establishment and operations of development control departments across Nigeria, the nation's Building assets has been plagued with quality deficit that exposes users of such buildings and the public to vulnerability to hazards and disasters resulting from building failures, thus the need for effective building control practice that would ensure construction standard. This study assesses the developmental control practices with the view of proposing a mechanism for an improved building standards in the Federal Capital Territory (FCT). This exploratory research adopted a pragmatic approach through mixed methodology design. This was done through administration of questionnaires survey and an interview of relevant stakeholders to the research context. The findings show that of all the constructs considered under the study, three (3) of which comprises of; improved institutional framework, increased enforcement and compliance level, and elimination of perceived challenges that constantly hindered the attainment of control department objectives were found to be critical for an improved developmental control towards an improved quality infrastructure in the study area. Therefore, a mechanism for developmental building control practices (MDBC) was developed. It is recommended that the MDBC be put into practice for the benefits of the built-environmental.

Keywords: Building standards, Development control, Federal capital territory, Mechanism

INTRODUCTION

Construction industry is that sector of the economy, which through planning and control transforms national resources into valuable assets necessary for human development and liveable built-environment, especially the building sector of any nations' national assets. The quality and quantity of these infrastructures within the national space accounts mostly for the stability and economic ratings of all nation. Procurement of capital infrastructures that meets the required standards within the building space, however, have been a major challenge over the years in developing countries (Isa *et al.*, 2013; Martin, 2018). Construction industry is said to be fragmented in nature, involving multitude of players such as the clients, consultants, engineers, architects, developers, and government agencies responsible for policy formulation, regulations and controls in the industry. The performance of the latter in harmonizing (control) the various interests of the stakeholders toward achieving the set goal (standard) within the building sector is very paramount to the expected outcomes of the industry (Charles, 2007& Ruya *et al.*, 2017).

Building control practices are set down procedures for certification of compliance, notice periods and other measures to support compliance with technical building regulations (Building Control Division (BCD), 2017). Building control practices must continue to meet the objectives of health and safety, amenity, sustainable buildings, coordinates reform activities to ensure consistency, encourage all mandatory requirements affecting building, facilitates an

efficient regulatory environment leading to an internationally competitive industry; and undertakes education and marketing activities to increase awareness of building regulatory reform (Ikpo, 2006). The less than perfect control in Nigerian building sector has resulted into existence of substandard structures, building crack, dilapidate and water leakage within the industry. On a larger scale, building collapse has been one of the major problems facing building developers in their quest for personal and investment developmental purposes, which has posed serious challenge to the stakeholders' ability to procure standard facilities in the construction industry (Akande *et al.,* 2016; Mansur & Tahar, 2017; Hilary *et al*., 2018).

Omeife & Windapo (2013) opined that building failures occur as a result of quacks and non-certified professionals parading themselves as professionals, normally patronized by ignorance or greedy clients in meeting their selfish needs. The low quality of capital infrastructures that dotted all over the landscape of developing countries, especially in Sub-Saharan Africa like Nigeria have been attributed to below average performance of the industry as whole. This scenario is also partly due to inadequacies of the development control units in organizing all her resources toward curbing unregulated building practices in towns and cities in developing countries (Hilary *et al.,* 2018). In Nigeria, building professionals have as a duty to practice their profession in accordance with statutory laws, the National Building Code (NBC), lack of supervisions, inspections and monitoring among others (Chinwokwu, 2000 Manur & Tahar, 2017; Akande *et al*., 2016; Hilary *et al.,* 2018; and Olufemi, 2018;). The statutory obligation of building control in the Federal Capital, Abuja was saddled with development control department, the Federal Capital Development Authority (FCDA). NBC provides the minimum standard for building, pre-design, design, construction and post-construction activities with a view to ensuring quality, safety and proficiency in the building industry (NBC, 2006; Development Control Manual (DCM), 2007; 2017).

Based on the above background, it is clear that the existing framework for developmental control requires an improvement to achieve it set objectives. The main question to be answered therefore is; what developmental building control mechanism can improve the standards of building stocks in the FCT. This study focused on building control practices in FCT, Abuja with a view to assess the existing framework, the degree of enforcement and compliance, challenges and effects leading to a propose mechanism for meeting the aim and objectives of the building control practices in the study area. The paper will be structured along the following sub-sections; literature review, research methodology, results and discussion, and conclusion.

LITERATURE REVIEW

Concept of Building Control Practices

The concept of building control practices is imperative to examine the two distinct words "Building" and "Control". Subsection 2.19 of the NBC (2006) sees a building as any structure or enclosure of space with a roof and walls for protection of life and property, which normally procured to serve a specific purpose. Whilst control is concern with the enforcement of statutory laws, regulatory controls and standards that govern their design, construction and operation in meeting the set standards (Circo, 2008; Ayuba *et al.,* 2012). Building represents a significant percentage of gross national products in terms of the resources needed for design, materials, construction, use, operation and maintenance. Therefore, it is the responsibility of the government to ensure that all construction plans are subjected to a quality control procedure

in enabling the safety of people and conducive building is achieved through an effective mechanism of control within limited resources.

The Building Standards

Building standards consist of planning standard, architectural standard, structural engineering standard, electrical engineering standard, mechanical engineering standard, structural stability, dimensional stability, freedom from damp, adequacy of services, good internal arrangement and quality construction materials in order to prevent building failures (Ikpo, 2006; Olagunju, 2012; DCM, 2017). Poor building control practices and activities of developers have resulted into substandard buildings, poor structural failures, building failures caused by poor quality management; structural design incompetence; structure overload and incompetent field production process which result into collapse, cracks, dilapidation, building deterioration and water leakages (Ikpo, 2006; Akande *et al.*, 2016). Therefore, there are needs for building control practices.

Implication of Building Control on Building Standards

The effectiveness of a regulatory system could be defined as the way the regulations contribute to the defined goals of the regulations (Visscher *et al.*, 2003). Building control practices are set-out to promote health and safety, reduce building collapse incident, qualitative housing and orderliness of the built-environment, certification of building works, issuance of certificate of completion and fitness for habitation, eliminate illegal structure, improve technical support and removal of construction waste in order to prevent substandard infrastructure (Beckers, 2013; Ayedun *et al.*, 2018;). These variables will have great implication on the current state of building assets and reduced drastically the occurrence of building failure, crack, dilapidated buildings and outright collapse, which have become alarming proportion in the state and FCT, Abuja prompting calls by associations of professional for the operationalization of the National Building Code (NBC) within the building industry (Aluko, 2011).

Challenges of Building Control Practices

The problems of building control practices normally arise from gradual deviation from master plan and de-regulatory authorities through distortion, alteration and deviation from planning standards (Aluko 2011; Olagunju 2012; Olufemi, 2018). The challenges in enforcing building control practices include: Inadequate funding for departmental activities; Improper monitoring of development control department; illegal conversion of approve right of usage; Act of bribery; poor motivation and corruptive tendency; Poor institutional framework; Lack of up-to-date land use map; and socio-cultural factors (Jibrin, 2013; Sheokowaga, 2016).

Strategies on Effective Development Building Control Practices.

For building control practices to be effective, five key operational constructs that can serve as the antinodes to the challenges of the practices in the industry have to be implemented. These constructs which are; Improve administrative framework, strengthening of building control practices and certification, Stakeholder's collaboration, Preventions to building failure measures, controlling effects of building control practices are as highlighted below;

- **Improve administrative framework:** this involves the improvement of the performance of the specific assign functions to the professional, such as, inspection, quality control, quality assurance, quality policy, sensitization and awareness, engagement of certified professional, and adequate funding (Abuja Metropolitan Management Council (AMMC), 2014; Noun, 2014; Olufemi, 2016).
- **Strengthening of building control practices and certification:** this includes; professional accreditation, mandatory certification, improved documentation, peer review, confidence building and ensure planning outcomes among others (Noun, 2014).
- **Stakeholder's collaboration:** this involves stakeholders working in unison towards attainment of building standards in areas such as; minimum acceptable standards, improve approval and certification process, mandatory critical stage inspection, policy improvement, improve document documentation, enhance compliance with approvals and standards, and improve the life cycle performance of building measures and features.
- **Preventions to building failure measures:** this involves the steps required preventing building failure through building control practices such as; frequent maintenance, building plan approval, soil test, quality material, buildability and maintainability assessment, involvement of professional from design stage, life-cycle assessment, and Proper Execution of building contracts (Ikpo, 2006; DCM, 2017; Noun, 2014). And,
- **Controlling Effects of Building Control Practices:** this involves; Introduction of a one-stop shop permitting system, Keep the building control as a duty of an authority, improvement of planning system, Issuance of certification and fitness for habitation, Identification and removal of distressed buildings to prevent collapse, Improve technical means – (IT, BIM), and Conducting research in building construction and control (Noun, 2014).

RESEARCH METHODOLOGY

The purpose of this research is to develop a mechanism for the developmental control practices towards improving the quality of building stocks in the FCT, Abuja. Abuja was chosen for this exploratory research, because apart from being the nation capital, it also houses a larger portion of building infrastructures currently under-development (unit of analysis) in the country (Creswell, 2012; AMMC, 2014). The research assumed a pragmatic approach by adopting mixed research method, which comprises of both quantitative and qualitative strands of inquiry to the study, in order to fully explore for better understanding of the constraints and boundaries of the study context (Creswell, 2012). The population for the quantitative strand of this research was drawn from the two main role players associated with the unit of analysis (see, Table 1). The population figures were from Development Control Department FCT and Abuja Property Development Company which consists of list of registered developers/contractors/consultants of the study area. The 369 development activities were however drawn from three municipal areas of Kuje, Bwari and Abuja Municipal for this study. This is based on the preliminary findings, that large portion of development activities that involves both developers and development control unit are in these three municipal councils (DCM, 2017).

Table 1: Research Population

S/N	Respondents	Population	Sample size
1	Developers	369	183
2	Building control officers	35	18
	Total	404	201

Source: (APDC, 2019; DDC, 2019).

A total number of 201 respondents were surveyed following the adoption of Yamane (1967) methods of sample survey. The study adopted a stratified sampling method between the two types of respondents. For the qualitative strand, eight experienced interviewees for purposively selected to give insights to the context of study. This comprises of three senior control officers and five developers with considerable experience (Loarine *et al.,* 2006). Structured questionnaire survey was self – administered to obtained data from the respondents. This process lasted for about 60 days to allow for considerable rate of return. While a semi – structured interview question was adopted for the face – to face interview that lasted for about 15 minutes per period (Cresewll, 2012). Descriptive and inferential statistics were used in the analysis of the quantitative data – Mean Item Score (MIS), Relative Importance Index (RII), Cronbach's alpha (α) and Factor Analysis. While content analysis was used for the qualitative data. The findings were sequentially triangulated for in-depth insight for the development for an effective strategy for quality control towards standard infrastructure development and improved infrastructure within the built – environment (Robson, 2011).

RESULTS AND DISCUSSION

This section presents the results and discussion therein in two sub – section. Firstly, to present the preliminary findings in a summary format, and secondly, to present the proposed mechanism for developmental control arising from results thereof.

Preliminary Findings and Discussion

The demographic descriptions of the respondents and the interviewee's shows a high composition of professionals; Builders, Architects, Engineers, and Surveyors (QS, Land, & Estate) with the required industry experience (8 years average) confirm their suitability to provide insights in the construct under consideration.

The assessment of the institutional framework for building control practices in FCT, Abuja shows various departments with specific but distinct functions. The departments are: Development permit; Building inspectorate; Amenities and aesthetics; Monitoring and Enforcement; and Logistics and ICT. Under development permit, variables such as advice on mitigation measure to prevent collapse (MIS = 4.80) and site inspection and site recommendation by site officers (MIS = 4.80) were ranked 1st respectively and considered most beneficial with the framework. In the building inspectorate department, variables such as inspection of slab, roof, setting out and recommend stage to stage development up to completion level (MIS = 4.68), inspecting and recommending setting out approvals for all approved building plan prior to physical development (MIS = 4.64) were considered most active and beneficial.

Under amenities and aesthetic, variables such as using the mobile court of the Abuja Environmental Protection Board to sanction wrongful dumping of construction waste by any

developers or renovation of properties (MIS = 4.60) and ensuring that scenic beauty of the City are maintained for effective ordering of city amenities (MIS = 4.52) were ranked 1st and 2nd respectively in the preference level. In the monitoring and enforcement unit, variables such as removal of illegal structures at the expiration of issued notices (MIS = 4.84) and resolution of controversies that may arise from title holders relating to developed properties (MIS = 4.68) were considered effective. Under logistic and ICTs variable such as collating and documenting all relevant technical records from the various divisions/units (MIS = 4.60) was considered most helpful in the operationalization of other departmental functions. Overall, the general perceptions of the respondents suggest that the institutional framework was effective and efficient with an average MIS of 4.00. This confidence level was collaborated by most of the interviewees that the department and their framework is actually relevant and essential for achieving building quality within the FCT. On the compliance level by the developers with the building control department (see, Table 2).

Table 2: Level of Compliance with Building Control Practices in FCT, Abuja

SN	Level of compliance	$\bar{X}$	Ranking
1	Notice to commence construction works	4.60	1st
2	Evidence of professional inputs; architect, builder, structural/electrical/mechanical engineers etc.	4.52	2nd
3	Erection of site sign Boards for critical information's for users	4.52	2nd
4	Apply for and ensure that all inspections are carried out by the Code Enforcement Officers	4.48	4th
5	Location of the project and purpose of development	4.44	5th
6	Obtain stage satisfactory completion certificates	4.04	6th
7	Notice of practical completion	3.92	7th
8	Obtain Certificate of Completion and Fitness for Habitation	3.80	8th

Source: (Researcher's Field Survey, 2019).

Interviewees 1 and 3 agreed that enforcement and compliance of building control practices was satisfactory but need improvement. Interviewees 2 and 5 confirmed that developers were forced to work in conformity with building standards to avoid loss of resources, however, required continuous inspection for full compliance.

Considering the challenges in enforcing building control practices. The challenges in enforcing building control practices were examined through developers and building control officer perspectives. Issues such as inadequate funding by authority (RII = 0.952) and physical development on circulation areas and parking lots (RII = 0.940) and poor record keeping were considered very detrimental to their operation. Other variables that hindered the operation of the departments are; lack of experience, improper monitoring of development control department, poor record keeping of data base and poor enforcement of development control guidelines. Majority of the considered variables are having above 0.700 relative importance index. Interviewees also confirmed that the major causes of slum development and illegal structure and village setting are lack of fund and building without building approval. The

respondent's perception on the implications of the building control practices on building standards were also assess. Interviewee 6 succinctly put it that

> "*If not for building control practices, all the so call 'master plan' cannot save federal capital from becoming a slum like any other city in Nigeria*"

A whole range of variables were considered to have a great implication on the standard of building infrastructure and operations of the industry as a whole. Respondents considered the department activities improved; poor design, professional negligence, compliance with codes and regulations, quality of material, respect for right – of – ways, enforcement of master plan, and engagement of professionals for quality building production in the study areas with an average of RII of 0.900.

Proposed Mechanism for Developmental Control

In line with the development control framework the findings of section 4.1 were considered for the development for the strategy for an effective building control towards achieving quality infrastructures. Firstly, Cronbach's alpha (α) (0.943) in Table 3, was used to test the reliability of the variables, the alpha scales of the variables were above the acceptable 0.6 (Spector, 1992).

Table 3: Reliability test for variables

Factors	**AF**	**SBCPC**	**SHC**	**SRPBF**	**CEBCP**
No. of variables	12	12	7	12	17
Cronbach alpha (α)	.696	.617	.613	.602	.738

Source: (Researcher's Computation, 2019).

Factor analysis technique was used. There are sixty (60) variables under consideration categorized into five (5) factors namely; Factor 1 - Administrative Framework (AF), Factor 2 - Strengthening Building Control Practices and Certification (SBCPC), Factor 3 – Stakeholder's collaboration (SHC), Factor 4 - Steps Required to Preventing Building Failure (SRPBF), Factor 5 - Controlling Effects of Building Control Practices (CEBCP). Principal component analysis with varimax rotation was performed on the 60 variables. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy of 0.679 was obtained which is higher than the recommended index by Pallant (2011). Factor analysis was used to reduce the variables in order to arrive at the most relevant variables towards the development of the mechanism for building control that can deliver quality infrastructures. Factor loading threshold of (FL = 0.700) was adopted for positively loaded variables. The results show a variable that are positively loaded of above the set thresholds under three major constructs, which are: Institutional Framework; Challenges; and Enforcement and compliance. This finding was collaborated by the words of interviewee 8, when the said;

> "*If the stakeholders (developers and control officers) can work within the institutional framework, where rules and regulations are follows as expected without whose ox is gored and the government has the political and economic wills to surmount the challenges facing the department, ……. sub-standards building development will be the things of the past."*

Interviewees 1 and 5 also suggested that the best strategies to eradicate the daily occurrence of illegal infrastructure and building failures are; provision of good remuneration for building officers, functioning site vehicles, adequate health and safety equipment's, and strict enforcement and compliance with building standard. Based on this analysis in conjunction with the expert's interview, a mechanism for effective building control practices was developed (Figure 1).

The Figure shows that with an effective institutional framework and a higher degree of enforcement and compliance on the part of every stakeholder will reduced the impact of the challenges militating against an improved building control strategy that can leads to improved quality infrastructure with in the built environment.

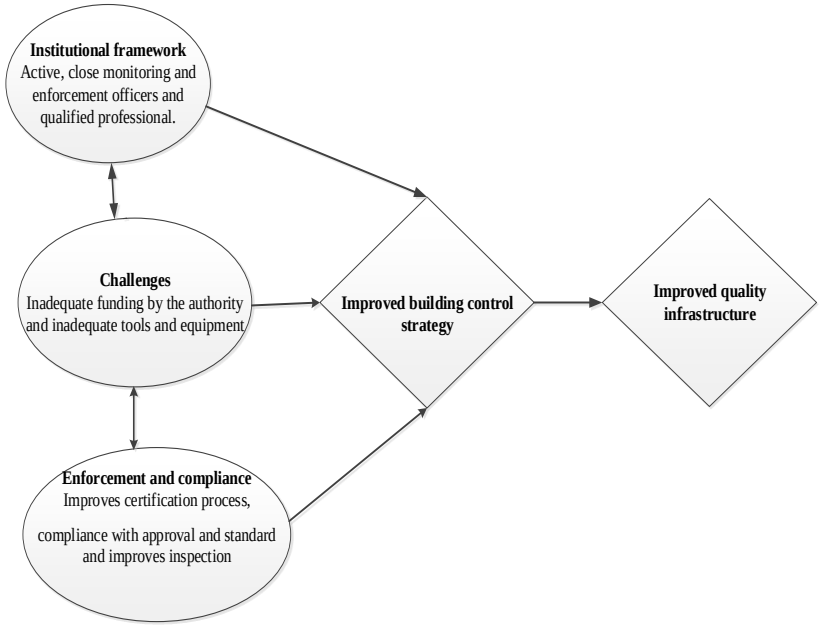

Figure 1: Mechanism for developmental building control practices

CONCLUDING REMARKS

This research work was set-out to develop a mechanism for developmental control strategy for an improved building infrastructure in the FCT. This was done through administration of questionnaires survey and interview of relevant stakeholders. Of all the constructs considered under the study, three of which comprises of improved institutional framework, enforcement and compliance, and elimination of perceived challenges were found to be critical for an improved developmental control towards an improved quality infrastructure in the study area. Therefore, a mechanism for developmental building control practices (MDBC) was developed. It is recommended that the MDBC be put into practice for the benefits of the built-environmental.

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Assessment of Facility Management Practices in Selected Public Health Care Facilities in Niger State

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Abstract

Facility Management (FM) is still in its infancy but growing due to the country's rising profile as one of the fastest growing entities in the emerging market economies. It is on this basis that the present study assesses the facility management practices in selected public health care facilities in Niger State. A mixed research survey design was adopted with the administration of questionnaires and interview to the health workers, works and maintenance officers (service providers) as well as end-users and visitors in Zone 'B', geographical zone of Niger State. A total of four hundred and fifty (450) questionnaires were administered (50 questionnaires to each Local Government under Zone B Niger, State, Nigeria) and interview were conducted with (9) in charge medical officers and (9) maintenance officers across the zone. The research data were analysed manually in tabular form using descriptive statistical procedures while the interview responses were analyse using content analysis. The outcome of the findings revealed that Outsourcing Facility Management and In-House (FM) are the two major types of FM adopted in the public healthcare facilities. Also improved funding, manpower in the works unit, waste management, contract and contractor management among others are the indicators for effective FM practices. The challenges facing the FM practices are unveiled to be corruption, insufficient funding, poor maintenance culture, problem of policy implementation, low technical knowhow. Finally measure recommended for improved FM practices are the adoption for effective are fitness for purpose/ functionality, ease of usage, benchmarking, building simulation/building forecasting, risk management in building facilities and building maintenance should be put in place by the government to encourage the uptake and adoption of FM practices in the healthcare facilities. Furthermore, there should be rigorous enlighten program on FM practice by government to improve healthcare standard and save lives.

Keyword*:* Facilities Management Practices, Public Healthcare, Building, Outsourced Managing Contractor and Outsourced Managing Agent.

1.0 INTRODUCTION

Public healthcare facilities in Nigeria are generally old and in a poor state. Healthcare facilities in Nigeria are faced with many challenges including poor maintenance culture and there is a need for the professionalisation of Facility Management. It is therefore essential for every healthcare district to have an effective FM practice. The lack of proper performance FM system in public healthcare facilities resulted in problems of various nature (Orubuloye 2008). FM is viewed as a secondary function in public hospitals, with professional FM expertise barely exists amongst most of them. Thus, few hospitals determine the maintenance needs for their facilities (Ilozor, 2013).

Facilities management (FM), as known today, is an important aspect in the built environment, dating back to the 1980s when railway companies in USA conceived the idea of providing facilities-related services as opposed to providing buildings (Ikediashi *et al*., 2013).

Since then, the concept and definitions have been evolving and many organizations have different views. The practice of Facilities Management (FM) is concerned with the process by which organisations ensure that their buildings, systems and services support core operations while contributing to the achievement of their strategic objective under stable business conditions (Bagshaw *et al*., 2015). Specifically, it deals with space design, construction,

allocation, strategy, property asset management, maintenance and post occupancy evaluation of premises, inventory management, value management and life cycle costing, computerization and office automation, management of support services, and so on (Achoru, 2015). The provision of healthcare facilities is needed to sustain life on earth. Unfortunately, in Nigeria today, the provision of health care facilities seems to be low as many Nigerians are vulnerably exposed to the danger of death (Abel, 2014). Within the context of hospital dispensary, clinics management, facility management has continued to live by its definition of creating the right enabling environment that supports the core mandate of rendering clinical and medical diagnostic services; which is why Shohet and Lavy (2006) considered healthcare facility management as one of the key elements for the successful delivery of healthcare services.

Essentially, one can contend that facility management adds value to hospital dispensary, clinics through achievement of zero defects in the healthcare service centres, especially in very delicate areas where very minute problems can have huge and devastating consequences and could be a matter of life and death. Other areas in which facility management adds value to healthcare delivery in hospitals include management of infrastructural facilities such as estate and property, indoor air, structure and fabric, water supply, electricity and telecommunication management referred to as hard facility management; and catering, cleaning, waste management, security and laundry services described as soft facility management (Liyanage and Egbu, 2008). Previous studies have shown underfunding, lack of understanding of the requirement of FM, inadequate budgetary releases, lack of qualified manpower, and incomplete infrastructure are some few major problems of facility management practices in our public health care facilities. The need of the study is borne out of the fact that most of the facility management practices are not consistent and effectively practice enough in our heath care facilities which have led to depreciation and they have lost their value. The aim of this research is to develop a framework for effective implementation of QM practice in Nigerian construction projects. Specific objectives of the study are to:

i. Identify the types of facility management practices in the selected public healthcare facilities.
ii. Identify indicators of effective implementation of facilities management practice for the health facilities in the study area.
iii. Determine the level of effectiveness of the identify practices in the selected public healthcare facilities.
iv. Determine the challenges of facilities management practices in public health care facilities in the study area.
v. Proffer strategies to improved facilities management practice in the study area.

2.0 RESEARCH METHODOLOGY

A quantitative and qualitative research methodology was found appropriate and adopted for this study. The study was utilised questionnaires, structured interviews, past research works, internet search engines and journals as the type data collecting instruments. It has been observed that one of the basic considerations that will inform the choice of a particular design one should use is the purpose of the study. The population of the study consist of health workers, maintenance officers (service providers) end-users, visitors and personnel of the selected public healthcare facilities in Chanchaga, Suleja, Tafa, Gurara, Bosso, Paiko, Rafi, Wushishi, Munya and Shiroro LGA within Niger State. Since the target population is very

large, the entire population cannot be studied due to resource constraint and time limitation. Hence, only 450 respondents were engaged for the study in the study area by targeting 50 respondents from each Local Government Area. Ranjit (2005) posited that for a sampling design to be called random sample, it is imperative that each element in the population has an equal and independent chance of selection in the sample. In view of this, a random sampling technique was adopted for the study. Also, interviews were carried out to 1 each of the head of the health workers (in-charge) and 1 head each of the maintenance unit. The questionnaire for the study was administered by the researcher himself. The questionnaires were well structured to address information about the individual respondent, background information about the particular healthcare facilities, the types, challenges, level of effectiveness and strategies Facility Management practices, level of availability of Facility Management practices in the building and extent of usage of Facility management in healthcare facilities will be sought to address the facility management practices in the particular healthcare facilities. After the questionnaires are administered to respective respondents. The researcher also conducts structured interviews with a sample of the interview guide to each 1 head of the health workers and 1 each of the maintenance unit head (18) from each Local Government Area in the study area) in order to seek additional insights and clarifications. All data collected with respect to this research will be analyse manually in tabular form using descriptive statistical procedures, particularly frequency distributions and simple cross-tabulations. Descriptive statistics such as tables, charts, percentages, means item score, relative important index; were used to present, analyse and rank the variables. Percentage was used to analyse the respondents' general information. Tables and/or charts were used to present the result of the analysis. Mean item score and percentages with correlation were used to analyse and rank variables in objectives 1, 2 and 3 to check the types of facility management practices in the selected public healthcare facilities, identify indicators of effective implementation of facilities management practice for the health facilities in the study area and determine the level of effectiveness of the identify practices in the selected public healthcare facilities.

3.0 RESULTS AND DISCUSSION

3.1 Identifying the types of facility management practices in the selected Public healthcare facilities

Findings on types of facility management practices in the selected public healthcare facilities were analysed as shown in Table 1.

S/N	FM practices	N*	MIS*	RANK
1	Outsourcing facility management	269	3.88	1st
2	In-house facility management	269	3.70	2nd
3	Outsourced Managing Agent FM Contract	269	2.88	3rd
4	Outsourced Managing Contractor FM Contract	269	2.73	4th
5	Total Facility Management (TFM) Contract	269	2.64	5th

Source: Authors' Field Survey (2020)

The result showed that outsourcing facility is has Mean Item Score (MIS=3.88), indicating adequate availability of outsourcing facility management which is ranked 1st, in-house facility takes the 2nd ranking with MIS = 3.70, which is also adequately practices. The Outsourced Managing Agent FM Contract, Outsourced Managing Contractor FM Contract and Total Facility Management (TFM) Contract has MIS score of 2.88 (3rd rank), 2.73 (4th rank) and 2.64 (rank 4th) respectively indicating that they are not adequately practices in the Public Healthcare Facilities management in Zone B, Niger State.

Table 1 Types of Facility Management Practices in the Selected Public Healthcare FacilitiesResponses from the interview conducted also disclosed that Outsourcing facility management and In-house facility management is widely practice among public health facilities in the study area. As disclosed by one of the interviewees that: "the available facilities management practice that I know we acknowledge in our healthcare centre here is the in-house facility management", it was also added by another respondent that: "the easy and mainly feasible healthcare facility management is the in-housing and basic outsourcing as we are still behind in infrastructural standard for other levels of facility management". This assertion of the present study is in line with other study Adewunmi *et al*. (2013) unveiled that Nigeria need to adopted best practice in facilities management, as it is only managing most of the facilities on in-house measure. Pitt and Hinks, (2011) contend that in-house FM is often seen as the management of cost-efficiency rather than as a method of achieving the multi-dimensional enhancement of business competitiveness.

3.2 Identifying indicators of effective implementation of facilities management practice for the health facilities in the study area.

The outcomes of the analysis indicators of effective implementation of facilities management practice for the health facilities in the study area was displayed in table 2 The respondents were of the view improved funding has MIS=3.61, manpower in the Works unit has MIS=3.32, Equipping the store in the FM unit of spare parts 3.32, Training/re-training of staff MIS=3.19,Changing old facilities to modern ones MIS=3.22, Waste management MIS=3.08, Space management (i.e. effective utilisation of space) MIS=3.28, Enhancing comfort and amenity for facility users MIS=3.00, Contract and contractor management MIS=2.94 and Building repairs and maintenance MIS=3.15. The result showed that there is very good implementation of indicators facilities management. From the interviewees also had to this fact, has stated by a management officer that: "there is turnover of attention to facility management with increase in manpower, increase in equipment as well as funding". Waste management is also an important indicator as stated by the interviewees, one of them says' "proper has been given to the adequate waste management in order to control the spread of disease such as malaria". Also building repairs and maintenance are also taking lead in the effective implementation of Facility Management Practice.

Finding of Adewunmi *et al.* (2013) supported these findings that the application of FM through indicators are essential to gain wide acceptance in Nigeria, which are assessment manpower in the Works unit, equipping the store in the FM unit of spare parts, Training/re-training of staff, changing old facilities to modern ones, waste management Space management (i.e. effective utilisation of space), enhancing comfort and amenity for facility users, Contract and contractor management among others.

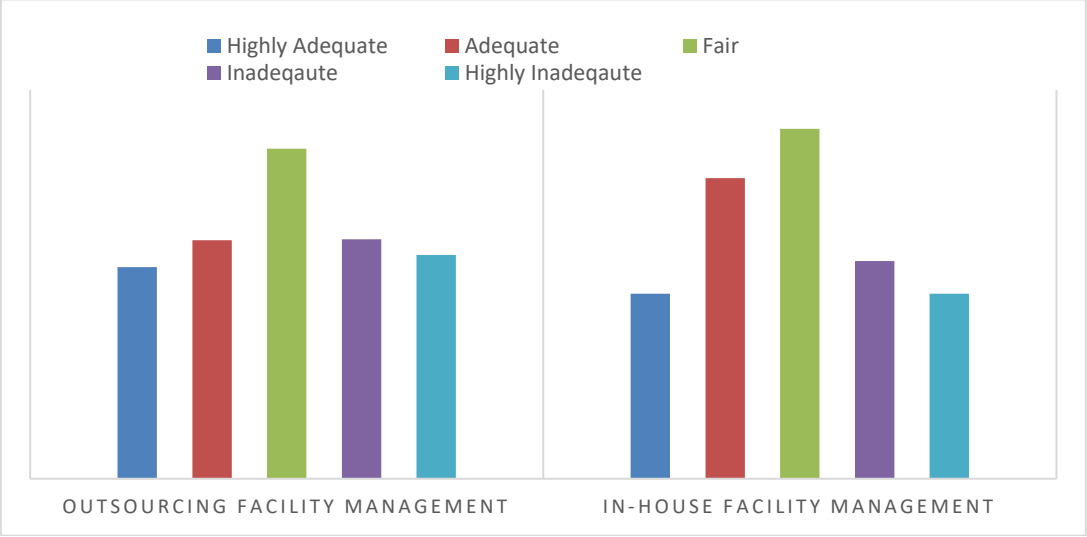
Table 2 Facility Management Practice Indicators

S/N	Facility Management Practice Indicators	N*	MIS*	RANK
1	Improved funding	269	3.61	1st
2	Manpower in the Works unit	269	3.32	2nd
3	Equipping the store in the FM unit of spare parts	269	3.32	2nd
4	Training/re-training of staff	269	3.19	5th
5	Changing old facilities to modern ones	269	3.22	4th
6	Waste management	269	3.08	8th
7	Space management (i.e., effective utilisation of space)	269	3.28	3rd
8	Enhancing comfort and amenity for facility users	269	3.00	7th
9	Contract and contractor management	269	2.94	9th
10	Building repairs and maintenance	269	3.15	6th

Source: Authors' Field Survey (2020)

3.3 Determine the level of effectiveness of the identify practices in the selected Public healthcare facilities

In regards to the outcome on the findings the types of management practices in the selected Public healthcare facilities, this section here by unveiled the level of effectiveness of the practices in Public healthcare facilities (Outsourcing facility management and In-house facility management). Figure 1 revealed that there is fair effective implementation of both outsourcing facility and in-house facility, management practices public healthcare facilities with MIS score of 3.82 and 4.05 respectively.



Source: Authors' Field Survey (2020)

Figure 1: Level of effectiveness of the facilities management practices

The interview response also backed this fact as one of the respondent says' that: "the Outsourcing facility management and In-house facility management practices are the available facilities management practice in our health sector yet it is not fully implemented". Another interviewee also lamented that: "the management practices are still fairly implemented though to lack of technical knowhow". In view of the responses there are still more to be done in the facilities management practice in the public healthcare facilities.

Correlation analysis was carried out to ascertain if there is a significant relationship between Facility Management Practice Indicators and level of effectiveness of the identify facilities management practices in Table 3. This analysis was achieved using Pearson's (R) correlation; the R-value indicates the strength of the relationship. Overall, the results showed a significant relationship among the variables tested, and in all P-value < 0.05.

Table 3: Simple Linear Relationship between facility management practice indicators and level of effectiveness of the identify facilities management practices

	Indicators	**Adoption**	**P**
Effectiveness of the identify facilities management practices	1	.596**	0.00
	.596**	1	

(Source: Researchers' Analysis, 2019)

Correlation is significant at the 0.01 level (2-tailed).

The outcome of the study is in line with that of Mustapha *et al.* (2008), who asserted that practice of FM in Malaysia at present is undertaken by real estate companies due to the fact that buildings such as high-rise office towers are managed by property consultants, who basically provide property and building management services as well as simple operations and maintenance. Similarly, a recent study which dwelt on properties, albeit commercial revealed that facilities provided in the studied high-rise buildings were in poor condition due to the "below-average" level of FM practice (Aliyu *et al.*, 2015).

3.4 To determine the challenges of facilities management practices in Public health care facilities in the study area

The result of the analysis on challenges of facilities management practices in Public health care facilities in the study area was displayed in Table 4, the unveiled that corruption take the highest ranking with relative importance index (RII=0.98), poor maintenance culture follows with RII=0.94, the 3rd ranking take the insufficient funding with RII =0.90, problem of policy implementation take the RII=0.88, inadequate facilities usage information takes 5th with RII=0.85, Insufficient FM personnel with RII=0.83 ranked 6th, Overcrowding in the building RII=0.79 with 7th, Age of the building 0.76 with 8th, Inadequate FM personnel skill level with RII=0.70 9th, Low technical know-how RII= 0.58 ranked 10th.

The outcome of the interview conducted also describe corruption, insufficient fund, poor maintenance culture, Problem of policy implementation and In-adequate facilities usage information among others. The 1st clear state the adverse effect of corruption to the adequate implementation of Facilities Management Practices in Public health care facilities in the study Area. He says' "The classical challenge mainly faced by the maintenance unit is corruption

which need urgent attention other challenges such as insufficient fund, poor maintenance culture and problem of policy implementation". Another interviewee says' "Maintenance and management culture is the greatest challenge we are facing, as well as insufficient fund and low technical knowhow in the health facilities". The outcome of the findings has proved the list of factors on Table 4 to be urgent issue needed to be address to ensure adequate implementation Facilities Management Practices in Public health care.

Table 4: Challenges of Facilities Management Practices in Public health care facilities in the study Area

S/N	Factors Affecting Facility Management Practice	N*	RII*	RANK
1	Corruption	352	0.98	1st
2	Insufficient funding	352	0.90	3rd
3	Poor maintenance culture	352	0.94	2nd
4	Problem of policy implementation	352	0.88	4th
5	Inadequate FM personnel skill level	352	0.70	9th
6	Low technical knowhow	352	0.58	10th
7	Insufficient FM personnel	352	0.83	6th
8	Age of the building	352	0.76	8th
9	Inadequate facilities usage information	352	0.85	5th
10	Overcrowding in the building	352	0.79	7th

Source: Authors' Field Survey (2020)

The findings also supported the findings of some researchers According to (de Silva, 2011) the lack of attention for future maintenance requirements was the most critical factor that gave rise to the problems, for instance, future needs with regard to frequency, method and access systems of cleaning and maintenance, budget, *etcetera*, should be considered at the pre-construction stage.

Also, the findings of Mustapa *et al.* (2008) that FM services are being undertaken by operatives who are traditionally blue-collar employees with limited training. This view was supported in a similar study in which the essence of competent facility managers was stressed. Interestingly, Ikediashi *et al.* (2013) explained that the sustainability of the FM services rendered was negatively affected by the dearth of trained FM professionals to handle intelligent and green buildings.

3.5 Proffer measures for improved facilities management practice in the study area.

As revealed from the outcome of the analysis on measures needed for improved facilities management practice in public health care facilities in the study area. The result on Table 5. show that fitness for purpose/ functionality has RII=0.98, followed by ease of usage with RII=0.97, aesthetics and psychological appeal has RII=0.95, structural stability has RII=0.94, accessibility/ access to the facility has RII=0.93, while modernity, Staff training and re-training, Number in use, Routine check on facilities and risk management has RII of 0.92, 0.90, 0.89, 0.85 and 0.83respectively.

Table 5 Measures for improved facilities management practice in the study area.

S/N	STATE OF FACILITIES	N*	RII*	RANK
1	Fitness for purpose/ functionality	352	0.98	1st
2	Aesthetics and psychological appeal	352	0.95	3rd
3	Modernity	352	0.89	8th
4	Ease of usage	352	0.97	2nd
5	Structural stability	352	0.94	4th
6	Accessibility/ access to the facility	352	0.93	5th
7	Number in use	352	0.90	7th
8	Staff training and re-training	352	0.92	6th
9	Routine check on facilities	352	0.85	9th
10	Risk management	352	0.83	10th

Source: Authors' Field Survey (2020)

The result show that all measures are believed to be vital for improved facilities management practice in the public healthcare facilities.

Responses of the interviewee differ from the opinion above has one the respondent says' "functionality is the key to proper management practices as it centres around any other necessities for the system", another interviewee says',' Ease of usage, structural stability and accessibility/ access to the facility and number in use should be taken into consideration as measure to adequate facilities management practice in the public healthcare facilities"

These findings backed the findings of Lavy (2010) ad it stressed that, the role facility managers fulfil is an exercise that is considered needed for success in health services. The following measures are important Aesthetics and psychological appeal, modernity, ease of usage, structural stability, accessibility/ access to the facility among others. And also, Adewunmi *et al.* (2013) argued that the application of FM and benchmarking in FM in particular are practices that are yet to gain wide acceptance in Nigeria, and IFMA (2009) highlighted. Lavy (2010), again stated that risk management should be a high priority for any facility, and it is achieved through a risk management program, in which risks are identified, analysed, classified and controlled.

4.0 CONCLUSION AND RECOMMENDATIONS

Based on the findings of the study, it could be concluded that outsourcing facility management and In-house facility management are the two major types of FM adopted in the public healthcare facilities. Also, that improved funding, manpower in the works unit, equipping the store in the FM unit of spare parts, Training/re-training of staff etc. are the indicators for effective FM practices. The challenges facing the FM practices are corruption, insufficient funding, poor maintenance culture, problem of policy implementation, inadequate FM personnel skill level, low technical knowhow among others. Finally measure cited for improved FM practices are fitness for purpose/ functionality, aesthetics and psychological appeal, modernity, ease of usage, structural stability, accessibility/ access to the facility and so

on. The researcher thereby recommended that strategic facility plan, benchmarking, building simulation/building forecasting, risk management in building facilities and building maintenance should be put in place by the government to encourage the uptake and adoption of FM practices in the healthcare facilities. The management of public healthcare centre; should attached importance to the FM practice and encourage, sanctions any staff found violating maintenance and management protocol in the healthcare facilities. The government should prioritize the provision of financial incentive and modern infrastructure to encourage FM practice with adequate planning and budgetary provision.

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Evaluation of the Roles of Niger State Housing Corporation under Public-Private Partnership as Strategy for Public Housing Delivery in Niger State

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Abstract

Public Private Partnership (PPP) as a strategy for public housing delivery in Niger state was introduced by the administration of Ibrahim Babaginda Aliyu in 2007 and it was used for all the seven housing estates embarked upon by the administration from 2007 to 2015 and Niger State Housing Corporation (NSHC) is the only legally recognized public housing development agency, with PPP achieving 0.91% over a period of 8years, this paper examines the role of the agency under the PPP arrangement. Focused interview (FI) was used to obtain data from principal officers of the Corporation such as the General Manager, Directors of Estates, Administration and Planning. Estate officers in charge of the estates and some of the contractors that participated in the execution of contracts were interviewed. Descriptive statistics was used to analyze the data obtained. The study discovered that the law that established the agency is obsolete, inadequate and incapable of accommodating the peculiarities of PPP, it was discovered also that there was no PPP regulatory law, thus, the agency could not function professionally in accordance to international best practices and this contributes to the woeful performance of 0.91% of PPP. The study recommends amongst others for the setting up a body of professionals to put PPP regulatory law in place in accordance to literature and international best practices.

Key words: *Public Private Partnership, Niger State Housing Corporation, PPP Regulatory Law, Public Housing Delivery, International Best Practices*

INTRODUCTION

Urbanization has been described as one of the most powerful and irreversible forces in the world and that about 93% of future urban population growth will occur in the urban cities of Asia and Africa and lesser percentage growth in Latin America and the Caribbean. It is further estimated that about 90% of recent urbanization has occurred in developing countries with urban areas recording about 70million new residents annually which is expected to double by 2030, a trend that is prevalent in South Asia and Sub-Saharan Africa that are adjudged to be the two poorest regions in the world (UN-HABITAT, 2011). The growth in urban population results in increases in demand for housing and housing facilities, services and infrastructure and this further asserts pressures on public budgetary allocations and results in the inability of governments all over the world in meeting the housing needs of their citizens. This development calls for the need to develop alternative strategies of public housing delivery that will achieve the dual results of greatly increasing the supply of affordable housing and drastically reduce the financial burden of government and this gave birth to the development of public private partnership as a strategy for implementing urban housing and infrastructure which started in the United Kingdom in 1960s known then as Private Finance Initiative(PFI), Sarafadeen and Akuakanwa,2015. Globally, over 40 nations including United Kingdom, United States of America, Australia, Ireland, Norway, Canada, Spain, France, Japan, Singapore, Finland, Malaysia and South Africa are engaging PPP in implementing urban

housing and infrastructure and the value of PPP projects rose from $79B with 241 projects to $350B in 2015 with a total 0f 1,046 projects (Yahaya, Ibrahim and Hariati,2020)

In Nigeria, the federal government introduced public private partnership as a strategy for public housing delivery towards increasing the housing stock through the National housing policy of 2006 (Aluko,2009) which is a collaboration between government and the organized private sector with detailed responsibilities, obligations and benefits of each party to the agreement and states in the country began to take after the steps of the federal government by engaging PPP as strategy for the provision of urban housing and infrastructure. From 1990 to 2009, over 51 projects were implemented through PPP (Vetiva, 2011) while 66 projects were prepared for implementation between the years 2013-2014 (ICRC, 2012), the values executed PPP projects also rose from $22M in 1997 to $3.1B in 2009(Yahaya et al, 2020). To ensure proper implementation, the federal government established the Infrastructure Concession Regulatory Commission in 2005 and approved a comprehensive nationwide PPP policy in 2009 which provides the roles of ICRC, other sectors as well that of Ministries, Departments and Agencies (MDAs) –Wahab, 2000: ICRC, 2012.

In Niger State, PPP as strategy for housing delivery was introduced by the administration of Governor Ibrahim Babangida Aliyu in 2007 which was used for the development of General M.I. Wushishi and Talba housing estates in Minna, Aliyu Makama housing estate, Bida and Bako Kontagora housing estate in Kontagora. Even though, PPP is been considered as a veritable means of housing provision, it has been observed that the extent to which government and its agencies are performing and responding to their changing roles has not been adequately addressed in literature and the paucity of information has obscured understanding on the role of public agencies in PPP and its implications on housing delivery (Eziyi,2010), Niger State Housing Corporation (NSHC) being the legally empowered public housing development agency, this paper shall therefore evaluate the role of the agency under the PPP arrangement.

Research Questions

The study shall answer the following questions as a guide towards achieving the objectives adopted by the study:

i. What were the roles of NSHC has enshrined in the law that established it?

ii.What are the housing projects undertaken through the engagement of PPP as housing strategy?

iii.What were the roles of NSHC under the PPP as a strategy for public housing development?

Aim and Objectives

The aim of the study is to undertake an evaluation of the roles of NSHC under PPP as a strategy for housing delivery in Niger State and to achieve this the following objectives shall be examined:

i. Identify the roles of NSHC as contained in the law that established the Corporation.

ii. Identify the housing projects undertaken through PPP from 2007 to 2015.

iii. Evaluate the roles of NSHC in the engagement of PPP for the developments of the housing projects identified above.

The Study Area

Niger state falls in the north central geo-political zone and it stands between longitudes 3^0 20'E and 7^0 40'E and longitudes 8^0 30N, it has a land area of 76, 469. 903 square kilometers which is 10% of the total land area of Nigeria and it is the state with the largest landmass. Niger state has a population of 3, 905, 249 (NPC, 2006) and it is bounded by Kaduna, Kogi, Nassarawa, Kwara, and Kebbi state as well as the federal capital territory (FCT) which creates an increasing demand on housing in Niger state.

From the creation of the state on the 13th day of February, 1976 Niger State Ministry of Works and Housing (NSMW&H) was saddled with public housing development and management until the establishment of Niger State Housing Corporation vide Edict No….of 1979

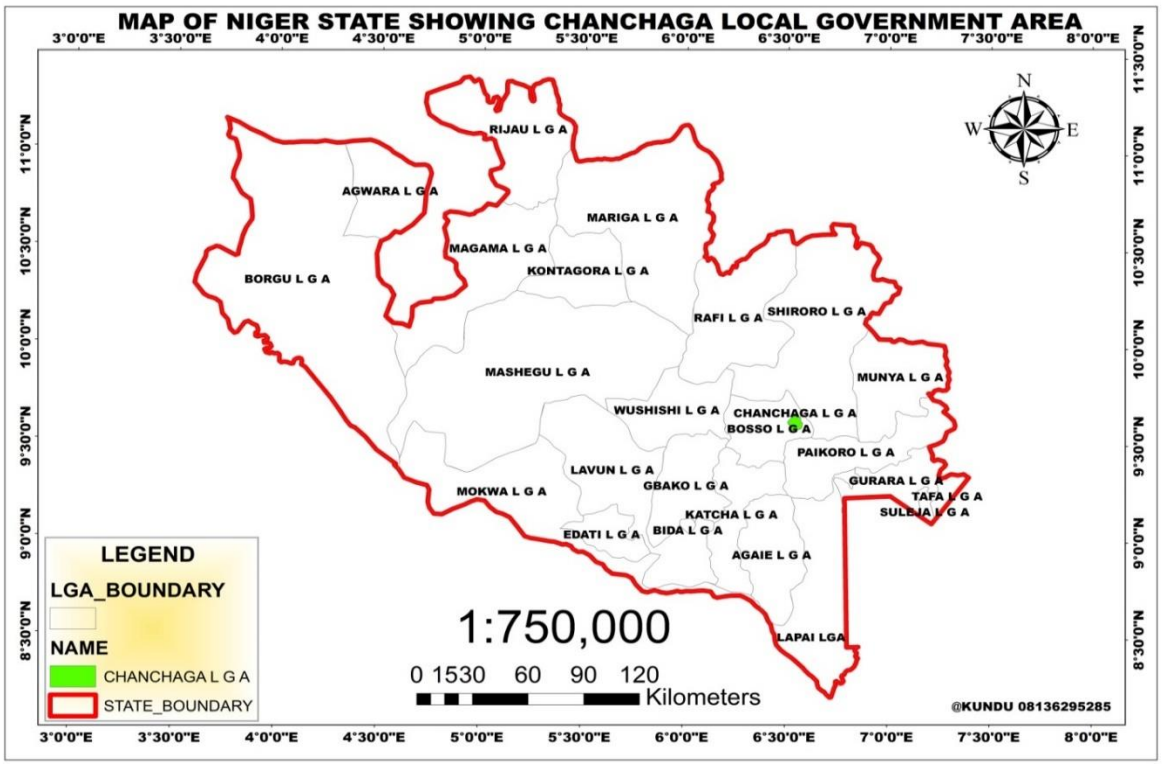

Figure 1: Map of Niger State

Source: Author's field work

LITERATURE REVIEW

This study reviews literatures on the concepts of public-private partnership, its engagement in public housing delivery, the expected roles of public agencies under the strategy and success factors and challenges in the engagement of the strategy for public housing development.

Concept of Public Private Partnership (PPP)

PPP has been defined as the pooling together of resources which includes financial, human, technical, land and intangibles such as information, political support, skills and expertise from public and private sources to achieve a commonly agreed goal (Fizbein and Lowden,1999),), a set of cooperative activities between the public and private sector (Agbola and Olatubara,2003), a collaborative efforts among public, private and third sector organizations who has mutually consented to cooperate together based on trust engaging the principle of division of labour, comparative advantage and a sharing of risks and benefits(Brinkerhoff and Brinkerhoff,2004, UN-HABITAT, 2006b) , it has also been defined as a range of relationship between the public and private sector who has agreed to cooperate together for the provision of specified facilities, services, infrastructure or housing (Kumar and Prasad,2004), a novel concept of executing public projects through a partnership arrangement with the private sector especially in the area of infrastructure (Aluko,2009), a finance model which is entirely driven by collaboration between the public, private and sometimes non-profit sectors and it is generally represents a more dynamic, long term agreement between various parties in which each party contributes and shares some level of risk (UN-HABITAT,2011), it is also viewed as the partnership between the public and private sector for the purpose of designing, planning, financing, constructing and/or operating projects which are traditionally considered as public responsibilities (Sarafadeen and Akuakanwa,2015).

This paper, views PPP as the pooling together of heterogeneous investors each with distinct capabilities, comparative advantages, skills and resources for the purpose of addressing socio-economic and developmental challenges of the society.

Conceptual Framework

As observed from the concept of PPP presented above, it can be generally referred to as a contractual relationship between the parties and its implementation as well as the outcome is numerous factors such as the composition of the parties, aim and objectives of the project, the roles of the partners and the economic, political, socio-cultural, technological as well as other environmental peculiarities within the area of operation of the PPP (UN-HABITAT, 2006b), furthermore, to ensure success of PPP, Yahaya and Ibrahim (2019) provided what they referred to as "critical success factors " and these are: favourable legal framework, commitment/responsibility of public/private sector, project technical feasibility, technology transfer, good governance, competitive procurement process, transparency procurement process, financial capability, available financial market, stable macro-economic conditions, involvement of civil society, an efficient approval process, sound economic policy, stable political environment and strong political support. The author's sequel to the study on the implementation of the strategy made a positive assertion on the capacity of the strategy to deliver adequate and affordable housing if the success factors are followed.

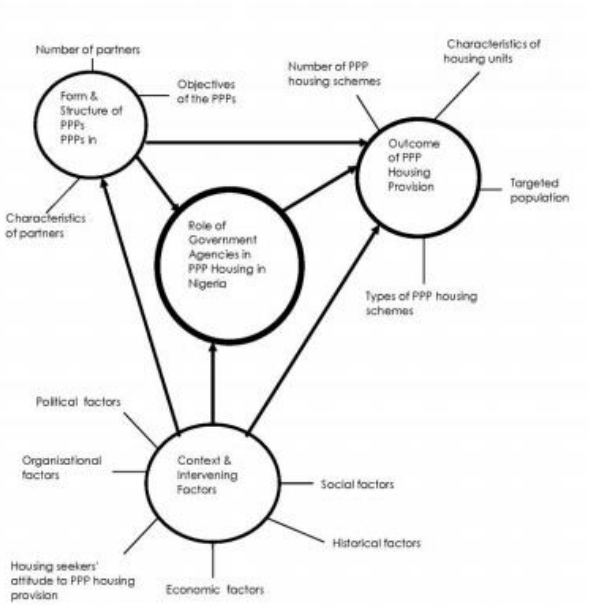

Figure 2: Framework for Assessing the Role of Government Agencies in PPPs (Eziyi, 2010).

For an objective and result-oriented assessments of the role of government agencies in the implementation of PPP, Eziyi, 2011 suggests that the assessor should possess adequate knowledge on the composition and characteristics of the PPP, the context of the situation in which they operate and the outcome of the housing provision scheme and this is in line with UN-HABITAT, 2006b, and went further to developed a conceptual framework (Figure 2) to explain the roles of government agencies in PPP.

The framework consists of three basic components with each component consisting of some variables to be considered for information gathering and analysis. The components are form and structure of the PPP, outcome of the PPP housing provision and context and intervening factors.

METHODOLOGY

Focused interview (FI) was used to obtain data from principal officers of the Corporation such as the General Manager, Directors of Estates, Administration and Planning, Estate officers in charge of the estates and some of the contractors that participated in the PPP housing projects. Descriptive statistics was used to analyze the data obtained.

DISCUSSION AND FINDINGS

The Roles and Responsibilities of NSHC

Table 1 provides a general overview of the functions of NSHC as the public housing development agency. As indicated above, the functions were derived from a law that was enacted in 1979 prior to the recognition and engagement of PPP as public housing development and delivery strategy at both federal and state level in 2007.

Table 1: Responsibilities of Niger State Housing Corporation (NSHC).

S/No.	Description of responsibilities	Section of the law
1	Recruitment of staff, staff welfare and discipline, payment of salaries and other sundry issues	Section A (i-xv)
2	Development of housing for the public and management of housing estates	Section B (6-9)
3	Generation of revenues (internally and externally) through borrowing, debenture etc, provision for expenditure, assets and liabilities	Section B (10-17)
4	Powers for acquisitions of land and compensation	Section B (20-21)
5	Operation of mortgage bank and staff housing loan scheme	Section B (m)

Source: Niger State Edict No. 5, 1979.

From the Table above, the functions of the Corporation as indicated under items 1-4, confers on the Corporation the carrying out of the entire development process which is contrary to the principles, operations and implementation of PPP as revealed in the literature review and this study observed that, there was no comprehensive law or document being put in place to address the complexities and peculiarities of PPP as advocated for in the literature review and the existing law is inadequate. Therefore, there was no proper legal and contractual definitions of the roles, functions and responsibilities of the organization in the implementation of PPP for housing delivery and this impaled the Corporation from functioning efficiently and professionally.

Table 2 indicates the housing projects that were embarked upon from 2007 to 2015, a total number of 219,000 was planned for development, 2000 housing units were developed and this gives an overall achievement of 0.91% which is below 1.0%.

Table 2: Housing Projects Embarked Upon through PPP from 2007 to 2015

S/No	Location	No planned	No constructed	% Achievement
1	Minna	10,000	1000	10
2	Suleja	10,000	300	3.0
3	Kontagora	5,000	250	5.0
4	Bida	5,000	250	5.0
5	New Bussa	4,000	100	2,5
6	Baro	5,000	100	2.5
7	20 other local government	180,000	-	-
	Total	**219,000**	**2,000**	**0.91**

Source: Field Survey, 2019

The study reveals that as a result of lack definitions of the roles of NSHC through a PPP regulatory law, there was therefore no requisite structure for proper implementation of the strategy and this did not prepare the agency for the critical roles it was to play towards the success of PPP and gives room for the politicization of the development process operation of

the PPP as housing development strategy was politicized as the duties, obligations and powers of the NSHC was usurped by politicians thereby reducing the Corporation to a mere supervisory agency. Furthermore, the state government did not prepare the agency for the critical roles it was to play towards the success of PPP housing projects by way of training, seminars and conferences and this does not allow the agency to perform professionally and successfully, this affirms the positions of Yahaya and Ibrahim (2019) and Yahaya, Ibrahim and Hariati (2020).

Evaluation of the Roles of NSHC under PPP Housing Projects

Due to lack of a comprehensive regulatory law for a successful implementation and operation of PPP thereby making the agency not being able to discharge its professional and crucial roles, the roles of the agency were reduced to the following:

i. Assigning representatives to the project sites for the purpose of supervision

ii.Making progress reports available to the government

iii.Receiving and processing of applications for allocation

iv.Liaising between the appointed mortgage institution and applicants seeking for mortgage loan

v.Keeping records of the allottees for the purpose loan deductions

vi.Monitoring of the housing projects to prevent illegal developments

vii.General management of the housing projects

SUMMARY OF FINDINGS

i.There was a law which stipulates the roles of and functions of NSHC, however, the law does not conform to the standard contractual requirements of PPP.

ii. Niger State Housing Corporation (NSHC), the agency saddled with public housing delivery could not perform professionally and efficiently under PPP

iii.The poor performance of PPP is partly attributable to the inability of NSHC to play its expected professional roles due to lack of PPP regulatory law.

iv.The actual roles played by the Corporation are secondary functions and mostly clerical in nature.

CONCLUSION

The study has evaluated the role of NSHC under PPP arrangement and lack of PPP regulatory law does not allow the Corporation to play the expected professional and leading role in the implementation of PPP for public housing development and delivery and this contributes immensely to the poor performance of PPP and failure.

RECOMMENDATIONS

Sequel to the analysis herein above presented, the study hereby proffers the following recommendations.

i. The State government should as a matter of urgency set up a committee of professionals comprising of Estate surveyors and valuers, architects, builders and other environmental professionals both in practice and academia and PPP experts from within and outside the state for the production of PPP regulatory law

ii.The government should reposition NSHC through training, seminars, retreats and conferences for acquisition of adequate knowledge and allow the agency to function professionally according to international best practices in the implementation of PPP as housing strategy in the state.

iii.Government to set up a commission that will be similar to Infrastructure Concession Regulatory Commission (ICRC) which operates at the federal level.

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Strategies for Disputes Reduction in the Nigerian Construction Process

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Abstract

Dispute has been observed as a common phenomenon in the construction process and has constituted several problems to project actors and the construction industry. Therefore, this research was conducted to find out the causes of disputes and to develop strategies that can be adopted by construction stakeholders to prevent it frequent occurrence in the construction process. To achieve this aim, a mixed methods research design was adopted in the study. The approach was adopted for robust data collection in the study. In the mixed methods, oral interview and questionnaire were the instrument used for data collection. The oral interview was first conducted with 16 construction stakeholders in five selected firms in Abuja. The data obtained in the interview study was analyzed through content analysis. The findings from the interview exercise served as basis for preparation of questionnaire that was later administered to some randomly selected construction firms in the study context. The data obtained from the questionnaire study was analyzed through descriptive statistics. The findings from the study show that lack of understanding and agreement on the type of contract, contractual payment, bridge of contract, and differing site condition are the main causes of disputes in Nigerian construction process. The study concluded that adequate knowledge of contractual document before the start of a project, bringing up contract conditions that are fair to all parties and maintaining a good relationship between the clients, professionals and workers are the strategies that can be adopted to overcome disputes in construction projects.

Keywords: Actors, Construction, Disputes, Framework, Projects.

INTRODUCTION

Construction is an important objective of a design and therefore the conversion of the design by its construction into a useable structure. This can be achieved by the means of human, materials, machineries, equipment and also the proper management of the resources (Peurifoy et al., 2006). The various and nature of activities in construction project makes it complex (Ashworth *et al.*, 2012). This implies that construction projects undergo series of activities that begins with the idea that comes from the brief and proceeds with a feasibility and viability analysis. Thereafter, the production of preliminary design, detailed design, buildability/maintainability analysis, procurement of resources, and maintenance until the building is finally handed over to the project owner. In these processes, dispute finds it root (Chern, 2009).

The parties involve in each of the above-mentioned processes contribute something different, but towards a common goal. Hence, the complexity of construction projects, in conjunction with the different parties at the various phases, and the enormous unforeseen circumstances such as the

management of resources (human and materials) make disputes unavoidable (Yiu and Cheung, 2006; Acharya et al., 2006). Chong (2011) viewed disputes as the internal disharmony existing among project team, which arises as a result of crooked intentions, communication or having the wrong troupe in important positions as the most dominant causes of disputes in the construction industry. Disputes is as essential as harmony because the main reason for seeking harmony is the existence of dispute and this is expected in the construction industry as in other part of human specialization (Lee, 2011). There are many factors that could lead to dispute. Such factors include; uncertainty, conceptual problems, and behaviour, other factors are change in scope, error in documentation, and ambiguous condition of contracts (Cheng *et al.,* 2009).

The impacts of disputes in construction projects cannot be over emphasized. Among these are late project delivery, increased project cost, productivity reduction, profit loss and damaged relationship (Love et al., 2009; Shuib et al., 2011). It is essential to know that dispute has led to non-actualization of the construction projects and the common problem of abandoned buildings in Nigeria. According to Cheung et al. (2004), when a dispute is not promptly and properly resolved in a project, it escalates and eventually requires a litigation proceeding which is extremely costly for the parties concerned.

Professional bodies and government have made substantial efforts particularly through the initiation of professional ethics to reduce the rate of disputes in construction industry, so as to improve project performance. Construction organizations have also made efforts to reduce disputes in projects by implementing renovates practices, technologies and techniques fixed within concepts like knowledge management, supply chain management, lean production. Considering this, disputes continue to prevail (Cheng *et al.,* 2009).

Despite the efforts that have been made by government and different organizations to overcome dispute in construction projects, its epidemic still lingers in Nigerian construction. Therefore, this study was conducted to find out the strategies that can be adopted to reduce disputes for effective projects delivery in the study context.

LITERATURE REVIEW

Concept of disputes

Construction projects are performed in diverse locations with several alteration and unstable conditions. These create tendency of dispute occurrences in projects. Mohammed, et al. (2008) perceived the management of construction project to be conglomerate because it is multi-ethnical and multi-disciplinary. The authors further explained that problems are resolved at all times basically from the project inception to the delivery by the team allotted, which is the principal lever to a successful project. Disagreements can result to one or both parties having grievance against one another which could later lead to conflicts. Dispute develops if a conflict is not properly attended to. When a conflict escalates into dispute, the project undertaken will be vulnerable to delay (Khanaki and Hassanzadeh, 2010; Griffiths et al., 2010). Therefore, it is important to resolve any grievance among parties involved in a conflict before it escalates into dispute.

Forms of disputes in construction projects

The literature indicates that there are several forms of dispute in construction projects. Among these are consultant, client, third party, contractor, management, quality of the work, work nature,

site status, sub-contractors, workers and safety issues related disputes (Acharya, *et al*., 2006; Eken, 2005). Study by Dada (2012) simply categorized disputes into internal and external. The internal disputes are those that occur among parties in a contract, such as clients, contractors, and consultants. While the external disputes are those that occur among project participants and external stakeholders.

Causes of dispute in construction projects

The nature and complexity of construction project contributes primarily to disputes (Cheng, *et al*., 2009). Hence, the causes of disputes can be summarised as refusal to pay specified sums, delay, termination, variation and misunderstanding in payment procedures (Chern, 2009; Farooqul *et al.*, 2014).

Strategies that can be applied to prevent disputes in construction projects

The literature reveals that alternative dispute resolution (ADR) strategy originated from the United States of America is commonly used as a means of resolving disputes on site. Though, ADR is broad and incorporates various processes, which are different from litigation system of disputes resolution. Therefore, the need for simpler strategies.

RESEARCH METHODOLOGY

The aim of this study is to develop strategies that can be adopted to reduce disputes among construction stakeholders in construction projects. To achieve this aim, survey research design was adopted. In the survey research design, mixed methods were used to obtain the necessary information from the participants of the study. To be precise, interview and questionnaire were the instruments used for data collection in the mixed methods. Interview was first conducted before the questionnaire exercise in the study. The interview was conducted among 16 managers in 16 different registered construction firms in Abuja in the year 2019. The 16 firms were randomly selected among the 32 registered construction firms discovered during the pilot survey phase of the study. The academic qualification of the interview participants ranges from BSc to master's degree. All the participants of the interview exercise were well experienced as they have been involved in different projects and have been working with different construction firms for more than 10 years. Semi-structure interview was conducted with each participant of the study in their respective offices. Each interview lasted for 30 to 45 minutes and took approximately three weeks in duration. Each of the interview was tape recorded and latter transcribed accordingly. The data obtained in the interview study was analysed using content analysis, and the themes that were drawn were used to prepare structured questionnaire that formed the second phase of the study. The essence of the questionnaire was to affirm the findings of the interview phase to a larger sample size in the study context. 150 questionnaires were distributed to randomly selected staff of the 16 case study firms. Out of the 150 distributed, 112 were returned which gave a response rate of 74.7% for the study. The information obtained in the questionnaire was analysed using descriptive statistics.

DATA PRESENTATION AND DISCUSSIONS

The interview phase

The purpose of the interview study was to find out the extent in which dispute can be prevented in construction projects. This was achieved by seeking the opinions of the participants on the various forms of disputes they have come across or experienced in their previous projects. The

causes of the various disputes and the strategies that can be adopted to overcome the disputes were also identified through the participants of the study. The themes obtained from the exercise are explained in the following headings:

The various forms of disputes in construction projects

In the interview conducted, seven forms of disputes were identified from the participants. These includes contractual, land, internal, financial, payment, management, and economic disputes. All the participants agreed that some of these disputes specifically financial and land occur frequently in projects, while some of them such as management and economic seldom experienced in the process. The opinions of the participants on the various forms of disputes and the frequency of their occurrence in construction projects are consisted with the views of Farooqul et al. (2014) and Dada (2012) on disputes resolution in projects.

Causes of dispute in construction projects

In the interview conducted, inadequate procurement/tendering method, bridge of contract, inadequate brief, poor communication, lack of understanding and agreement on the type of

contract, differing site and incomplete design information condition were emphasized by six of the participants as the major causes of disputes in construction projects. While four of the participants identified change order, absence of team spirit among members of the project, misplacement of priority, discrepancies/ambiguities in the contract documents, inadequate descriptions of the preliminary items in the bill of quantity (BOQ), improper planning/site management and failure to use specified material, skilled operatives/ recognized methods as the main causes of disputes in construction projects.

Further, three of the participants affirmed government intervention, fraud act of the party and parties failing to identify and deal with issues on time as the main factors responsible for disputes in projects. Whilst, the remaining three of the participants emphasized that inaccurate response to the problems presented by one party to another party in the contract, failure of sharing risks, unrealistic claims for variation of works by contractors, limited resources (scarcity) and the contractor's failure to price properly for the works as the causes of disputes in projects. The opinions of all the participants are synonymous with the findings of Missis (2012), Peansupap and Cheang (2015) on the causes of disputes in construction projects. Similarly, Mba (2013) had earlier identified inadequate procurement/tendering method, bridge of contract and poor communication as the major causes of disputes in construction projects.

The strategies that can be applied to prevent disputes in construction projects.

According to the participants of the interview study, seven strategies can be adopted by project actors to prevent disputes in construction projects. These strategies are to:

- Design or make contract conditions fair enough to all parties;
- Understand contractual document before proceeding into agreement;
- Proper planning and organization of payment and schedule;
- Make payment as at when due;
- Maintain a good relationship between the clients, professionals and workers;
- Engage organization professionals, and
- Engage the organization trained artisans/labours.

These findings are consistent with the opinions of Sinha and Wayal (2007) and Ntiyakunze (2011) on the various strategies that can be applied to reduce disputes in construction projects.

The survey phase

The questionnaires survey was conducted to compare the collective perceptions of clients and construction professionals from the themes that were drawn in the interviews section of the study to a large sample size. The outcomes of the exercise are presented as follow:

Ranking of the respondents' perceptions on disputes in construction projects

The MIS of all the respondents in the survey study ranges from 4.66 to 3.78 (Table 1). These imply that all the respondents agreed on the variables discovered in the interview phase as the main form of disputes in construction projects.

Table 1: Ranking of respondents' perception on forms of Disputes in projects

S/N	Causes of Disputes	5	4	3	2	1	NR	TS	MIS	SI	RANK
1.	Contractual Dispute	77	32	3	0	0	112	531	4.66	0.529	1st
2.	Payment Dispute	63	45	2	2	0	112	505	4.51	0.396	2nd
3.	Land Dispute	64	41	6	1	0	112	504	4.50	0.414	3rd
4.	Internal Dispute	58	51	3	0	0	112	503	4.49	0.306	4th
5.	Financial Dispute	59	36	10	3	0	112	485	4.33	0.710	5th
6.	Management Dispute	36	63	4	10	0	112	468	4.18	0.490	6th
7.	Economic Dispute	32	39	25	16	0	112	423	3.78	1.040	7th

KEY: 5= Strongly agree, **4**= Agree, **3**= Neutral, **2**= Disagree, **1**= Strongly disagree, **NR**= Number of respondents, **TS**= Total score, **MIS**= Mean Item Score, **RII**= Relative importance index, **SI**= Significant index**.**

Ranking of the causes of disputes in construction projects

The MIS of all the respondents in this question also ranges from 4.65 to 4.13 (Table 2), which also indicate total agreement in the findings of the interview and questionnaire sections of the study.

Table 2: Ranking of respondents' perception to the causes of disputes

S/N	Causes of Disputes	5	4	3	2	1	NR	TS	MIS	SI	RANK
1.	Lack of understanding and agreement on the type of contract	74	37	1	0	0	112	521	4.65	0.497	1st
2.	Differing site condition	72	36	4	0	0	112	516	4.61	0.559	2nd
3.	Bridge of contract	68	39	5	0	0	112	511	4.56	0.582	3rd
4.	Inadequate procurement/Tendering method	65	43	4	0	0	112	509	4.54	0.568	4th
5.	Incomplete design information	56	55	1	0	0	112	503	4.49	0.520	5th
6.	Poor communication	59	47	6	0	0	112	501	4.47	0.600	6th
7.	Improper planning and site management	54	51	6	1	0	112	494	4.41	0.637	7th
8.	Failure to use specified materials, skilled operatives and recognized methods	53	49	10	0	0	112	491	4.38	0.647	8th
9.	Discrepancies/ ambiguities in contract documents	44	63	5	0	0	112	487	4.35	0.565	9th
10.	Inadequate brief	43	64	5	0	0	112	486	4.34	0.562	10th
11.	Inadequate descriptions of the preliminary items in the BOQ	45	61	2	4	0	112	483	4.31	0.685	11th
12.	Change order	34	75	3	0	0	112	479	4.28	0.506	12th
13.	The absence of team spirit among members of the project	39	58	13	2	0	112	470	4.20	0.708	13th
14.	Government intervention;	41	52	14	5	0	112	465	4.15	0.808	14th
15.	Misplacement of priority	41	47	21	3	0	112	462	4.13	0.807	15th

KEY: 5= Strongly agree, **4**= Agree, **3**= Neutral, **2**= Disagree, **1**= Strongly disagree, **NR**= Number of respondents, **TS**= Total score, **MIS**= Mean Item Score, **RII**= Relative importance index, **SI**= Significant index.

Methods of preventing disputes in construction projects

Based on the MIS obtained in this question (Table 3), it can be emphasized that the information obtained in the questionnaire section is in agreement with the interview study.

Table 3: Ranking of respondents' perception to the methods of preventing disputes

S/N	Methods of preventing Disputes	5	4	3	2	1	NR	TS	MIS	SI	RANK
1.	Understanding contractual document before proceeding into agreement	83	29	0	0	0	112	531	4.74	0.44	1st
2.	Designing contract conditions that are fair to all parties (allocating projects risks fairly to all parties) to unstable price of materials)	81	31	0	0	0	112	529	4.72	0.45	2nd
3.	Proper planning and organization of payment and schedule	78	34	0	0	0	112	526	4.70	0.46	3rd
4.	Maintaining a good relationship between the clients, professionals and workers	72	38	2	0	0	112	518	4.63	0.52	4th
5.	Payment as at when due	58	41	13	0	0	112	493	4.40	0.69	5th
6.	Engaging the organization trained artisans/labours	43	53	16	0	0	112	475	4.24	0.69	6th
7.	Engaging the organization professionals	44	49	19	0	0	112	473	4.22	0.72	7th

KEY: 5= Strongly agree, **4**= Agree, **3**= Neutral, **2**= Disagree, **1**= Strongly disagree, **NR**= Number of respondents, **TS**= Total score, **MIS**= Mean Item Score, **RII**= Relative importance index, **SI**= Significant index.

CONCLUSION

Based on the study conducted, it can be concluded that seven forms of disputes are liable to arise in construction projects. Among these are contractual, payment and land disputes which are prevalent in every project. While management and economic disputes are not that common. It can also be said that there are twenty-two causes of disputes in projects. The identified causes such as lack of understanding and agreement on the type of contract, differing site condition, bridge of contract, inadequate procurement/tendering method and incomplete design information were observed as the main factors responsible for disputes in construction projects.

Based on the identified causes of disputes discovered in this study, understanding contractual document before proceeding into agreement, designing contract conditions that are fair to all parties, proper planning and organization of payment and schedule are hereby recommended as the strategies that can be adopted by project actors to overcome disputes in construction projects. Therefore,

- Parties to a contract should understand contractual document before proceeding into agreement.
- Contract conditions should be designed to be fair to all parties i.e., allocating projects risks fair enough to all parties.
- There should be proper planning and organization of payment and schedule by both clients and contactors before the commencement of projects.

- Clients should engage the organization professionals in executing project.

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Assessment of Energy Conservation Measures in the Design of Postgraduate Student Hostels in Northern Nigerian Universities

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Abstract:
The environment today is facing challenges as a result of urbanization and has led to the depletion of available resources such as; water, land, air and energy which has in turn changed into an artificial living environment. The rate of energy being consumed in student hostels is daily on the increase with the advancement in technology and student enrolment. The study identified and assessed the designs of postgraduate student hostel buildings, focusing mainly on the energy conservation design measures that were adopted in the designs. The survey adopted a qualitative research method where a scheduled checklist was used to collect data from the selected case studies. Findings from the survey suggests that, mostly owing to trending technologies in design and maintenance, most postgraduate student hostel designs have shaded away from the use of passive design measures and are now focused on achieving aesthetics. The study concludes that passive design measures have not been efficiently utilized in the designs of most postgraduate hostels. As such, the incorporation of energy conservation measures should be made mandatory at design level prior to the approval of any student hostel building plan. This can further reduce the demand for mechanical power which at the moment is inadequate to attain thermal comfort of the occupants.

Keywords*: Energy, Conservation, Postgraduate, Hostel and Design.*

INTRODUCTION

The core function of a building envelop is to efficiently provide comfort for its occupants in the midst of adverse and variable external environmental conditions. Living in a building that provides an efficient thermal comfort is very important as it ensures occupants' healthy living and enhances the building's performance. According to Adunola, (2011) occupants over time tend to adapt to their living environments however, most of them will prefer to live in an environment that provides comfort rather than enduring in a building that does not. Ismail et al., (2009) stated that a hostel design that ensures occupants' comfort is very important, because a bad thermal condition in a hostel building will affect the productivity and health of the occupants. Yazeed et al., (2018) stated that symptoms such as tiredness, headache and aggressiveness are the usual side effects associated with a bad thermal comfort condition. The postgraduate hostel should also in the same vain be made to be comfortable for the students coming in for advanced learning.

In recent times, the effect of global warming and climate change has made providing occupants' comfort in a building to become very fundamental and quite challenging. The idea of passive design techniques for energy conservation means that a building will make use of the natural climate in order to sustain a comfortable temperature for its occupants (Hyde, 2000). Passive design tends to maximise the natural means of heating and cooling of the indoor living space for instance, the use of the sun and the cooling breeze (Caitlin, 2013). Passive design can also be series of design measures that seeks to increase the thermal efficiency of the building by giving attention to the utilization of natural ventilation through building orientation, building insulation, window placement and designs (Larsen, 2015). Hyde, Caitlin and Larsen all suggested the use of the natural existing climate as a major factor in achieving a conducive space cooling and heating for occupants of any type of building without the use mechanical

appliances. Therefore, Passive design can also be seen as an effective strategy used in cutting down energy costs as they do not require energy powered devices. Several studies carried out have concluded that, passive design helps to reduce the necessity of a mechanical heating and cooling, which usually accounts for about 40% of the total energy been used in an average building.

The aim of this study therefore is assessing the designs of postgraduate hostel buildings in northern Nigerian universities, focusing mainly on the energy conservation design measures that were adopted in the designs.

STATEMENT OF PROBLEM

The environment today is facing challenges as a result of urbanization and has led to the depletion of available resources such as; water, land, air and energy which has in turn changed into an artificial living environment (Abd'razack, et al., 2012). The energy consumption in student hostel buildings is quite high and is expected to increase as a result of improved technologies and increase in the number of students enrolled into the universities for postgraduate studies. The effect of energy conserved or consumed within the hostel has over time had impacts on the productivity and performance of the students (Abayomi, 2005). Depending on mechanical energy to achieve thermal comfort of students within Nigerian hostel is becoming more expensive and challenging by the day. Therefore, the problems of how to effectively reduce cost in the presence of the rising cost of energy and increasing postgraduate student enrolment among other running cost are certainly giving challenges to the university managements across the nation.

LITERATURE REVIEW

According to Bhatia, (2002) a hostel building can be described as a building that is used to provide a temporary and inexpensive accommodation to people (mainly students, workers and travellers). Davies et al., (2008) has described a hostel as an institution that can create cheaper lodging and also food services to both travellers and students. It was further defined as a less profit-driven provision of shared rooms, common areas and other facilities to serve as temporal accommodation for students. Hostels are built putting into consideration some formal or institutional features and to also provide a convenient access to the students' recreational facilities (Olanipekun, 2014). For a building to function as a hostel, the building needs to efficiently satisfy other human needs that ensures comfortability in terms of safety, need for territory, convenience, privacy and accessibility. Sekhar and Goh (2011) stated that a living student environment that does not provide thermal comfort can affect the quality of sleep and in turn affects the performance of students during the daytime. Lack of adequate sleep time can easily result to tiredness, headaches and even aggressive behaviours. The long-term effects of all these will lead to loose of concentration in class and eventualy poor overall academic performance. The provision of adequate hostel accommodation can serve as a medium by which the quality of education delivered is been enhanced in most academic settings (Nicol, 2004). According to Perkin and Will (2001), the need to create adequate spaces that can allow active communication, convenience, healthy living and chances for socialization are major factors in the design of student housing in any given college or university design. In addition, it was further affirmed that all the outlined parameters need to be put into consideration along with the adequate spatial requirement for furniture arrangement, incorporation of efficient mechanical network, plumbing, electrical and most of all the safety requirements when designing students' hostel.

In times past, electricity bills and cost of fuel did not directly pose any form of financial threat to the University management as a result of the low rate of electricity tariff, cost of fuel and student enrolment. However, all these have drastically been hiked at an alarming rate mostly as a result of the increasing students' enrolment, cost of energy, infrastructural development, modern technologies and unstable government allocation. Itabor, et al., (2015) carried out a survey to examine the energy saving potentials on the postgraduate hostels at the University of Benin, in an attempt to reduce the rate of energy consumption in postgraduate hostels in Nigeria. Oyedepo et al., (2016) carried out another survey on the assessment of energy consumption in Covenant University in which different buildings within the campus were assessed to the determine energy consumption rates and the results were represented in the chart below as follows;

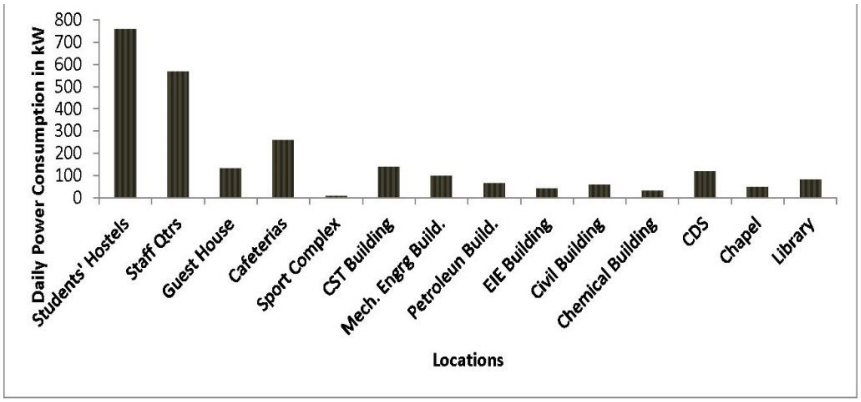

Figure 1: Showing the daily energy consumption rate in various buildings in Covenant University
Source: Oyedepo, (2016)

The study concluded that the heating and cooling systems in student hostels consumes more energy when compared to other buildings within the campus.

Yazeed et al., (2018) carried out a simulation test on Sulieman Hall in Ahmadu Bello University, Zaria with the aim of evaluating the thermal comfort in the university hostels. Findings from the study confirms that the level of thermal comfort in the hostels is unsatisfactory throughout the year. The study concluded that most professionals in the building industry today have side-lined the use of passive techniques to achieve occupants' comfort in the indoor environment and in return have placed focus on the use of mechanical energy to achieve comfort in an enclosed living space.

Olanipekun, (2014) carried out a study to evaluate the thermal comfort and occupants' behaviour in a naturally ventilated hostel in the Warm-Humid Climate of Ile-Ife, Nigeria using the female hostel in Obafemi Awolowo University, Ile-Ife, as a case study. The major findings deduced from the study showed that none of the hostels studied were in compliance with the thermal conditions stipulated by ASHRAE. The study also revealed that in an attempt to achieve thermal comfort, 77.4% of the respondent preferred window opening, while 77.3% preferred wearing light clothes in place of the use fan as a result of inadequate power supply. The study concluded that achieving the standard thermal comfort through natural ventilation during hot season in Ile-Ife may be quite difficult.

The findings from these studies amongst several of their kinds have led to the introduction and adoption of energy conserving materials and techniques to build, having in mind that one of the key functions of a building envelop is to protect its occupants against severe outdoor

environment and to provide a comfortable and healthy indoor environment that will conserve energy.

Hostel configuration

The various configuration of student hostels differs from one another in the design forms and height of the buildings. The blocks can be straight or form a geometrical figure such as the T, U, and L shape. The various hostel rooms are arranged sequentially in a linear pattern adjacent to a corridor and stair case while, toilets are situated around the end corners or even middle. The straight or I-geometrical plan shapes are usually too long, forming a monotonous elevation and due to the open configuration of the hostel shape, it gives a little or no privacy.

Energy conservation measure

The concept of energy conservation design can be said to be when a building takes advantage of natural climate to sustain a calm internal temperature for its occupants (Michael et al., 2013). This further suggest that there will be a reduced rate in the use of mechanical powered device to heat and cool the indoor environment of the occupants. Applying energy conservation techniques during the design stage of a building is highly recommended. Also, from an economical perspective, it is quite easier to implement such measures before the actual construction of the building. However, considerable and simple renovation works can be done to any existing building and the process can also give a cost-efficient channel to improving the thermal well-being and in turn conserve energy. These processes may require much studies and creativeness from the architects because any error at the design stage can attract some consequences to the building. According to Caitlin, (2013) the identified energy conservation measures are; building orientation, material, texture and colour, landscaping, courtyard techniques, window openings, shading, and thermal mass.

METHODOLOGY

This study adopted a qualitative research method where a scheduled checklist was used to collect data from the selected case studies. This process involved a study of some selected postgraduate hostel buildings in northern Nigeria, evaluating the degree to which the building designs were able to adopt the energy conservation measures. The energy conservation measures deduced from the literature review were used as parameters to assess the postgraduate hostel buildings that were studied.

Study area

The research was conducted in three selected postgraduate university hostels in northern Nigeria. The universities are namely; Abubakar Tafawa Balewa University (ATBU) postgraduate hostel, Ahmadu Bello University (ABU) Postgraduate hostel, Bayero University of Kano (BUK) postgraduate hostel.

Population and sample selection

This research population comprises of postgraduate hostels in northern Nigeria. A purposive sampling method was adopted to select three (3) postgraduate hostels. The research selects with intent individuals and sites to learn or comprehend the central phenomenon (Creswell, 2012). The areas selected comprises of prototype room designs of a single room ensuit and one-bedroom ensuit. A total of 5 units of single rooms were picked at random from each of the selected postgraduate hostel which were carefully examined.

DATA COLLECTION

The methods that were used are; visual survey and the checklist. The objective of this instrument is to collect data based on the level of adoption of the energy conservation measures in the selected hostel buildings. The outlined variables were used to assess the energy conservation measure during the survey. The relevant aspects suitable to achieve the aim of this study deals with the close observation of the following variables; thermal mass, landscape, courtyard, Shading, materials colour and texture and other external features.

RESULTS AND DISCUSSION

Landscape

The hostels that were studied in the course of this research work mostly had adequate spaces and landscape designs. Grasses, trees and shrubs were mostly adopted in 25%, 75% and 25% respectively as the major elements of landscape. These clearly shows that the concept of energy conservation through landscape is a paramount measure that needs to be adopted to achieve thermal comfort and aesthetics. Other observations made included the poor maintenance of the landscape elements that was created.

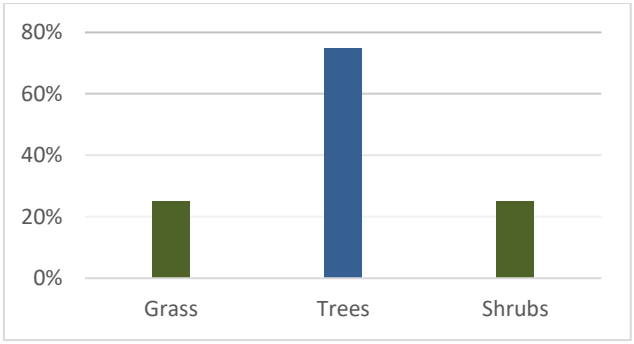

Figure 2: Showing adoption of landscape
Source: Author's Fieldwork (2019)

Courtyard

The concept of courtyard was adopted in most of the buildings that were studied.

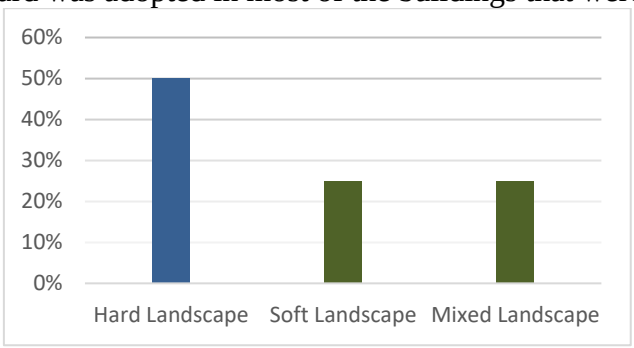

Figure 3: Showing adoption of Courtyard
Source: Author's Fieldwork (2019)

However, the most effective means which involves the use of soft landscape is rated 25%, while hard landscape and mixed landscape were 25% and 50% respectively. Courtyards used in some of the buildings were very narrow or tunnel-like, which has significantly reduced the rate sufficient air flow into and from the building.

Material, colour and texture

The external walls of the buildings mostly had smooth and light colours on their surfaces. Smooth and light colour for exteriors of buildings can help to reflect the solar radiation without allowing heat to be transmitted unto the inside of the building. As observed, this measure was adopted to achieve aesthetics and serve the major function of a building's envelope (wall) which is to control excessive energy gain or loss.

Window openings

The type of windows used mostly adopted the passive design techniques as regards opening type, sizes and unit number. The casement window which allows 100% free flow of air through the window opening had 75% level of adoption while sliding and fixed windows recorded 25% and 50% respectively.

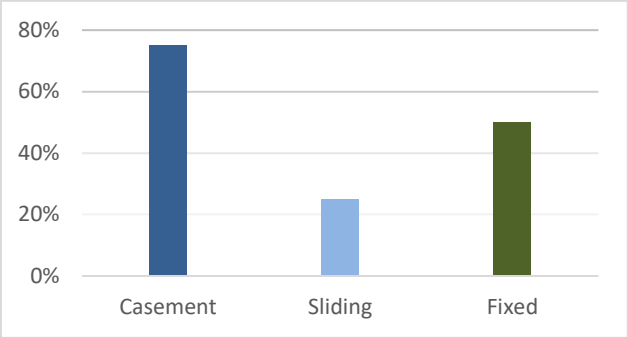

Figure 4: Showing adoption of window opening
Source: Author's Fieldwork (2019)

Window Shading

The energy conservation measure of shading was not efficiently utilized in the postgraduate hostel buildings. Aesthetics was also the utmost priority as observed that, 25% of the windows had internal shading. Also carefully observed from the study is the use of concrete skirting of about 25mm thick were mostly used on the exterior which measured up to 75%.

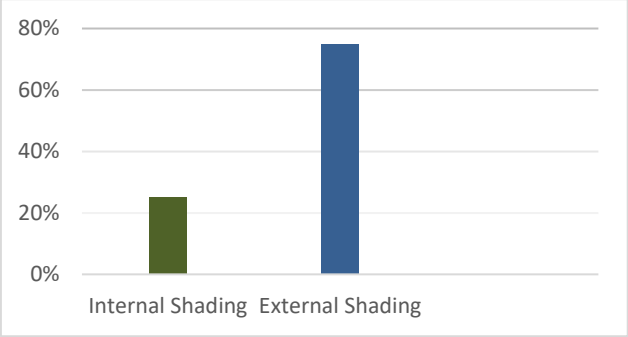

Figure 5: Showing adoption of Shading
Source: Author's Fieldwork (2019)

The use of fin overhangs which was observed to have started becoming obsolete in the designs of postgraduate hostel building.

Building orientation

The buildings studied in the course of the study were mostly not adopting the energy conservation measure as the buildings were oriented on site in various directions that can make the building receive more heat energy from the sun in most hours of the day time. The best direction to orientate buildings as established from various studies are the North and South directions.

Thermal mass

This measure was adequately adopted as a means of energy conservation. The brick walls had a 100% level of adoption while ceramic tiles and adobe plaster were incorporated at 50% and 25% respectively.

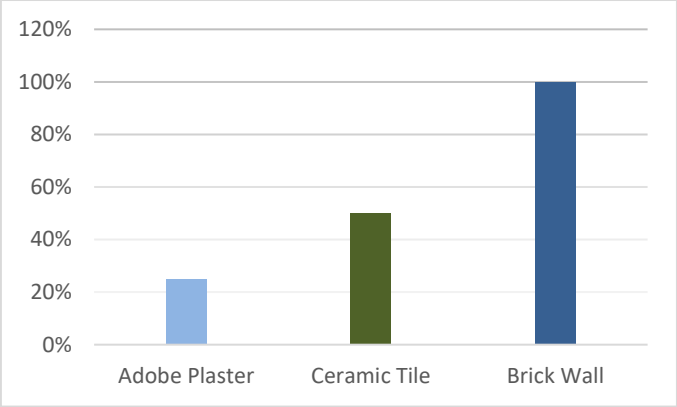

Figure 6: Showing adoption of Thermal mass
Source: Author's Fieldwork (2019)

CONCLUSIONS AND RECOMENDATIONS

The study to assess the energy conservation measures on the postgraduate hostel buildings has shown an average level of adoption of the energy conservation measures in general. This was conspicuously observed in the attempt to achieve the conservation measures through design. Mostly owing to trending technologies in design and maintenance, most postgraduate hostel buildings have shaded away from these measures to majorly focus on aesthetics. A continuation in this manner of shading away from these measures can pose a harmful effect on the coming generation as the population of humans in all human settlement is daily on the increase and also observed to have effects on the productivity of the students

Postgraduate students' hostels which are the temporal living environment for students needs the conservation measures to be also adopted in their design just as it is adopted in other residential building. Thermal comfort can impose other detrimental effect if ignored and as such, energy conservation measures needs to be put into strict consideration in order to achieve good living environment for postgraduate students.

The following recommendations will help address the issue. Design plans taken for approvals should incorporate most of the energy conservation measures effectively. Technologies that completely disagrees with these energy conservation measures in hostel settings should be avoided or technically reviewed. A timely check should also follow after it has been adopted as its effects in a case of partial compliance can be detrimental to the health and safety of the students.

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A Review of Housing Potentials in Curbing Pandemic: A Post Covid-19 Analysis

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Abstract:

The coronavirus (COVID-19) outbreak, declared a global pandemic by the WHO, has become the most trending subject of the year, wreaking havoc on the economy and affecting many individuals' lives companies in a variety of sectors, capital markets, and supply chains. All capital investments have benefits and drawbacks. However, without a reference to pandemics in the unforeseeable plan, the announcement of a pandemic by WHO followed the immediate termination and delays of many housing projects worldwide. But how does COVID-19 affect the housing industry, and are owners and contractors prepared to deal with the outbreak's fallout? This study has reviewed the impact of past pandemics on housing sectors and how they overcame the challenges posed to the housing project. The study also investigates the correlation between past pandemic with present COVID-19 to identify the building sectors and suggest the possible solution to overcome such challenges.

Keywords: Covid-19 Pandemic, Housing Pandemic, Construction Housing Covid -19

INTRODUCTION

The pandemic has turned the world beyond our front doors into a new wasteland. Unless they are essential to staff, outdoor spaces are now places to be avoided because our environments have shrunk to the scale of our homes for the rest of us.

Sars, Mers, Ebola, bird flu, swine flu, and now Covid-19 have all been seen in the twenty-first century. How should we plan future cities so that the outdoors may not become a no-go zone but remains a secure and habitable area if we have indeed reached a pandemic era?

With the COVID -19 pandemic's severity fluctuating, this year's World Habitat Day theme, "Housing for Everyone - A Better Urban Future," may not be more timely. With nearly 90% of all COVID -19 cases reported in urban areas and a clear correlation between homelessness and infection rates, there is an immediate need to investigate our cities and towns' fault lines.

According to the former UN Special Reporter on Adequate Housing, entry to adequate accommodation is now more than ever a matter of life and death. Housing is one of the most critical factors affecting health outcomes and deciding how vulnerable an individual is to extreme COVID -19 effects. If you do not have a secure and safe place to live, is almost virtually difficult to protect yourself and others from the infection.

About 1.8 billion people worldwide are homeless or live in "grossly insufficient" housing. The risk of infection is not significantly reduced for those housed in the substandard shelter since many are forced to live or work in close quarters with others and share already overcrowded areas, including water and sanitation facilities.

Pandemics are large-scale outbreaks of infectious disease that can trigger significant economic, social, and political devastation while often increasing morbidity and mortality over a large geographic region. Data shows that pandemics have become more possible over the last century

due to increased world travel and interconnectedness, urbanization, land-use changes, and greater exploitation of the natural environment (Jones, 2008). These patterns are expected to persist and become more pronounced. The need to identify and control new diseases that could contribute to pandemics and extend and maintain investments in developing preparedness and health capability may be a forefront of strategy.

The world community has made strides in anticipating and preventing pandemics. Many countries established pandemic preparations in response to the 2003 Serious Acute Respiratory Syndrome (SARS) pandemic and increasing fears about the danger of avian influenza (Services, 2005). The World Health Organization has updated the International Health Regulations (IHR) to mandate all World Health Organization member states to follow certain criteria for identifying, monitoring, and responding to outbreaks as a result of the late reporting of the first cases of SARS. The revised IHR's architecture helped to create a more organized global response.

During the pandemic of influenza in 2009 (Katz, 2009). International donors have also started to engage in bettering preparedness by developing new criteria and providing funds for health capability growth (Wolicki, 2016).

WHAT IS A PANDEMIC

A pandemic is a disease that threatens the whole world. It happens when a bacterial or viral infection has the potential to spread rapidly and easily (Taylor, 2019). A pandemic, according to the World Health Organization, is the global outbreak of a new epidemic and a pandemic, unlike influenza, is not limited to a single city, province, or country; it can extend across national boundaries and even the globe. When the number of individuals infected in a given area exceeds the expected number, authorities deem the illness to be an outbreak.

The latest COVID-19 pandemic has brought the globalized world to a halt, claiming the lives of hundreds of thousands of people and putting millions on ‘lockdown' in their homes. Since the economic consequences are still being felt, one of the many areas impacted is the housing market. Early data shows that prices and demand have been steadily declining in some highly impacted cities, while other regions have not, or have not yet, suffered such impacts. For example, rental rates in Manhattan have been quickly declining, whilst demand in New York's surrounding suburbs has risen (He and Harris, 2020).

However, there is also considerable doubt around the short-term influence of COVID-19 on urban housing markets, and it is not yet possible to predict if the pandemic would have any long-term effects on cities' and housing markets' potential development trajectories. In general, determining the effect of epidemics on housing markets is difficult, both in the short and long term. In general, determining the effect of epidemics on housing markets is difficult, both in the short and long term. Though pandemics are usually exogenous, they are often infrequent, so data availability is restricted. Experts argue that the latest pandemic is the worst since the Spanish Flu, which occurred over a century ago (Ferguson et al., 2020).

History of some Pandemic

From 1918 to 1920, the Spanish flu pandemic took the lives of 100 million people. Experts believe it to be the deadliest pandemic of human history. In the 14th century, the Black Death killed over 75 million individuals. The below are examples of pandemics that have existed in history (Begović, 2021):

- **541 to 542:** Justinian Plague
- **1346 to 1350:** The Black Death

- **1899 to 1923:** Sixth cholera
- **1918 to 1920:** Spanish flu (H1N1)
- **1957 to 1958:** Asian flu (H2N2)
- **1968 to 1969:** Hong Kong flu
- **2009 to 2010:** Swine flu (H1N1)
- **2020:** COVID-19

Viruses carried by animals are seldom transmitted to humans. This virus will also mutate and become transmissible to and within humans. When an animal virus spreads to humans for the first time, public health authorities declare it a possible pandemic. This suggests that a virus could mutate and become incredibly infectious and deadly (Begović, 2021).

Swine flu and bird flu are infectious infections that have only affected pigs and chickens, not humans. When an antigenic shift happened, this shifted.

There have also been concerns in recent years regarding viruses related to camels (Middle East Respiratory Syndrome, or MERS-CoV) and monkeys (Middle East Respiratory Syndrome, or MERS-CoV) (Ebola).

The COVID-19 Pandemic

The outbreaks occurred during a period of rapid population development all over the globe. In the nineteenth century, Paris expanded exponentially, and Amsterdam endured its Golden Age before the outbreaks reached the capital. Similarly, today, the epidemics have a huge impact on everyday life and the economy, and disproportionately impacted poorer regions with significant urbanization more than wealthier areas. This is also supported by new data for the latest pandemic (Almagro, Coven, Gupta, and Orane-Hutchinson, 2020; Arthi and Parman, 2021; Borjas, 2020) Even though the COVID-19 virus first infected people in Wuhan, China, before spreading across the world, WHO's advice and more than a third of the world's population has been quarantined. Several countries have locked their borders, including the United States, the United Kingdom, India, and China, impacting global travel and business.

Many people have lost their employment when "non-essential" companies have closed to save the epidemic from spreading. In several locations, restaurants, gyms, religious organizations, parks, and offices have been closed. A pandemic will put more strain on healthcare services by rising demand for specific therapies. Extreme COVID -19 signs necessitate the use of more ventilators and ICU beds. As a consequence, support for those that use these devices may be limited (Khan and Naushad, 2020). Therefore, housing remains a critical antidote for the pandemic as the emergency policy of stay at home became the new normal.

HOUSING CONCEPT DEFINITION

Housing plays an important role in each country's economic envelopment, accounting for 10-20 per cent of total economic development in the country and becoming the largest fixed asset of households. Housing is not only one of the most important human needs, but it is also a measure of the population's living standard. Today, it is a contentious issue that accommodation must be convenient, affordable, and fairly maintainable, as well as architecturally expressive and environmentally friendly (Henilane, 2016; Tomal, 2020)

Before the pandemics and in the face of the ongoing pandemic, the COVID 19, the housing demand-supply disparity is a topic of ongoing debate in the field of urban housing. Aside from accelerated urbanization and economic pressures, socio-demographic shifts and lifestyle diversification have resulted in a need for more diverse housing solutions (De Paris and Lopes,

2018). For example, it seems that many people are looking for a more economical, sustainable, or social way of life. However, as previous research has shown, diversifying the offering of mass-produced housing is a dynamic structural task that necessitates the cooperation of multiple players, including the public and private sectors, as well as residents It has been shown that laypeople's perceptions of what is feasible and attractive are heavily influenced by the current housing stock. This implies that simply telling people about their immediate housing needs or reviewing current housing will not be enough to generate new ideas. Instead, more in-depth participatory mechanisms that concretize new ideas by creative concepts and pilot projects can be advantageous. In conventional urban housing, for example, the relationship between private residence and shared facilities have remained relatively static since the industrial period, influencing our behaviour and aspirations (Pirinen and Tervo, 2020). However, the current scenario may require a comprehensive integration of the new normal brought by the COVID 19 pandemic with the formal for more enhanced housing.

Analysis of Housing Policy Objectives

In everyone's existence, it is essential to meet both real and intangible needs. Along with food and clothes, housing is one of the essential material needs of a person.

In response to COVID-19, National Alliance for Recovery Residences, (NARR) developed recovery residence-specific resources based on CDC guidance and contributed to the development of guidelines for residential settings (Mericle et al., 2020)

Personal hygiene, particularly handwashing, is critical for preventing respiratory infections and requires access to clean water and the absence of clean water is a common problem and places where drugs are used are often unhygienic and it critical to the new normal (Vasylyeva, Smyrnov, Strathdee, and Friedman, 2020).

A previous study presented an analysis of housing policy objectives in the context of an effective approach allows for the identification of six relevant dimensions (Bruno and Fontana, 2021) which includes:

(1) Smart economy: A favourable environment for economic development as a result of a virtuous combination of entrepreneurship, innovation, internationalization, productivity, and competitiveness; also, thanks to the high flexibility of the labour market and widespread change management skills;

(2) Smart people: A favourable environment for the generation, accumulation, and dissemination of human and social capital, whose development is supported not only by high levels of education, coupled with positive attitudes toward lifelong learning, but also by mental opening, pluralism, creativity, and active citizenship;

(3) Smart living: A favourable environment for the quality of life of citizens and the community of reference, but also the city’s attractiveness to tourists and visitors (compatible with its natural, cultural, and commercial features);

(4) Smart environment: An urban context focused on natural conditions, environmental protection, containment of pollution levels, and the responsible and sustainable management of natural resources;

(5) Smart mobility: A context that ensures physical and virtual access to, and mobility within, the city, its facilities, and its activities—referring to networks and services of both transport and telecommunications;

(6) Smart governance: A citizen-centred public administration, adopting features of openness, simplification, transparency, involvement, and accountability, to ensure effective policy interventions and efficient public services.

Housing and Pandemic

The COVID -19 pandemic has wreaked havoc on financial markets, economies and societies worldwide including the housing market, but policymakers have swiftly replied with a slew of policies aimed at reducing the crisis's negative effect on renters, creditors, developers, and lenders (Francke and Korevaar, 2021; Liu, 2021). However, many of these interventions, whether they are temporary, can obstruct a vigorous recovery and/or hinder the housing market's responsiveness to society's evolving needs (Francke and Korevaar, 2021). Figure 1 represents Rental market controls, for example, benefit tenants in the short term. Still, they usually stifle supply by making housing construction less open to increasing demand and posing obstacles to residential mobility. In light of this, this note offers new information on the effect of the COVID -19 crisis on development operation and opportunities, analyses government policy responses, and addresses trade-offs between sustaining short-term housing stability for tenants and mortgage holders, promoting mobility, and ensuring adequate, environmentally safe supply (Bruno and Fontana, 2021; Francke and Korevaar, 2021; Liu, 2021).

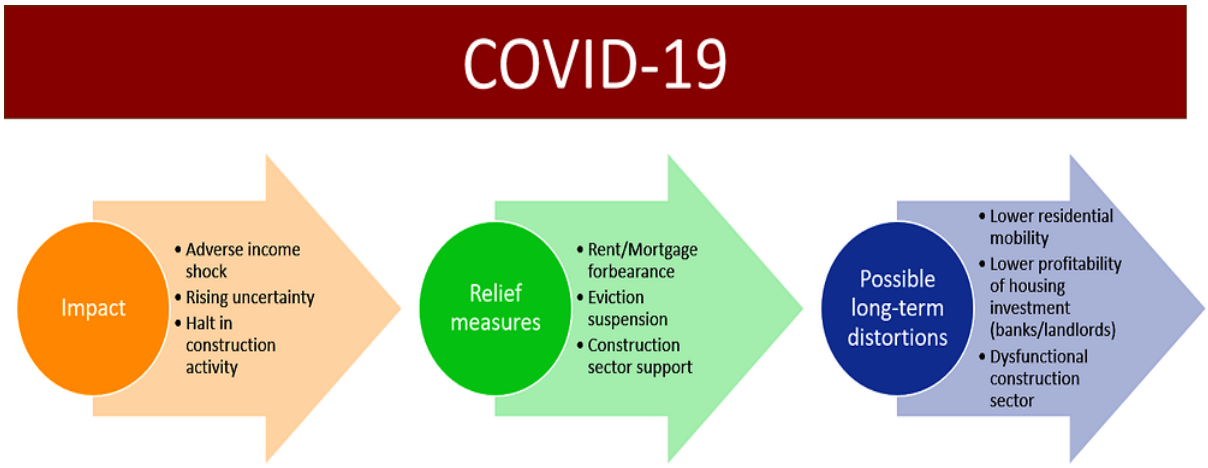

Figure 1: Housing policy responses to COVID-19 could lead to long-term distortions.
Source: Organization for Economic Cooperation and Development (OECD)

Understanding the specific housing conditions and the associated health and safety risks is essential to developing effective strategies to improve the health, safety, durability and sustainability of the housing stock (Gloux, 2021) .On this note, cities installed drainage services to improve sanitation, which ultimately led to indoor plumbing due to the new understanding that living conditions in cities could have public health consequences. Toilets became a regular feature in homes as a result of this pandemic (D'Ovidio et al., 2021).

Pandemics have traditionally prompted urban creativity, and the COVID -19 is no exception. Smart cities are expected to emerge from the pandemic in the areas of transit and 5G connectivity, but smart homes cannot be overlooked (Allam and Jones, 2021).

Cities are home to more residents than ever before, resulting in millions of people living in dilapidated homes. Most multifamily housing is archaic when it comes to addressing new

telecommuting, transit, and energy efficiency demands. The new pandemic has also resulted in a rise in short-term relocations, indicating that many residents are discovering that their city homes are no longer suitable for their lifestyle and health needs (Allam and Jones, 2021).
Previous pandemics have always been a time for modern life to be reinvented. Today's pandemic tells real estate investors that it's time to consider a modern standard of living that encourages healthy living spaces.

PAST PANDEMICS: ADAPTING TO NEW HOUSING NEEDS

History has replicated itself when it comes to pandemics and new housing developments(de Waal, 2021). We also developed a new awareness of how accommodation affects our health with each illness.
In addition to earlier signs of modernization after cholera outbreaks, tuberculosis outbreaks prompted advances in water purification systems such as sand filtration and chlorination. Many major manufacturing cities in the United States enacted laws requiring toilet rooms in any housing unit in the early 1900s (Tulchinsky and Varavikova, 2014).
The Spanish Flu pandemic of 1918 continued to improve ventilation standards. Following the pandemic, public health authorities noticed tightly packed urban buildings helped the disease transmission (Breitnauer, 2020). New advances in open spaces and air circulation were inspired by a better understanding of how influenza travels across the air. Houses continued to be built with porches and walls, and subsequent legislation in the United States mandated that all homes have fire escapes, three-foot-wide hallways, and private bathrooms (Breitnauer, 2020; de Waal, 2021).

If we begin to respond to recent discoveries in disease prevention and technology innovations, housing patterns represent health trends over time. Each pandemic has taught us something new about what people in their homes want (Barry, 2020).

A new opportunity to re-evaluate urban living (Allam and Jones, 2021; Barry, 2020; Bruno and Fontana, 2021; D'Ovidio et al., 2021)

- Following COVID-19, the housing services that served us well a year ago seem to have been outdated. Our everyday routines have been dramatically changed as a result of the crisis, from where we work and how we get around and how we shop — and all of these changes are sure to continue.
- We are driving our cars: As city dwellers reconsidered public transit and pooled drives, COVID-19 sparked a rise in vehicle ownership. Many multifamily properties, especially those in urban areas near public transit, would see a rise in residents who need parking.
- We are working from home: The shift to remote work necessitated the introduction of high-speed internet and secure Wi-Fi in our houses, but not everyone has this luxury. 62 million people in the United States' urban areas lack high-speed internet connectivity.
- We are placing our order through the internet: The pandemic has increased the move to online retail by five years, with e-commerce revenues projected to grow by about 20% by 2020.
- We like to see less contact: Even before the pandemic, contactless building entry was becoming more popular. It is no longer a "nice-to-have," but now a health problem.

- We are more energy-conscious: People are spending more time at home than ever before, and they want to save money while still protecting the COVID-19 environmental developments.

The new standard of living will look smarter

As yesterday's fire escapes and flush toilets give way to tomorrow's smart home ideas, the timing is perfect for housing innovation. In the 1800s, plumbing was the most modern technology available. Today is the internet of things (IoT). Smart sensors and data-driven analytics will help us apply the post-COVID solutions we need (Kamal, Aljohani, and Alanazi, 2020).

As a result of the increase in vehicle ownership and private transit, smart parking, for example, will become the modern norm. Smart parking systems allow digital maps for real-time space availability, electronic parking meters, and parking sensors (Al-Turjman and Malekloo, 2019). IoT also enables housing upgrades to meet environmental needs, reduce waste, and allow greater monitoring of energy consumption, thanks to smart thermostats, smart lighting, and leak sensors.

In the same way that the Spanish flu told us about breathing, COVID-19 has prioritized contact-free rooms. Keyless entry and fob access will become the new norm in apartments as residents seek contactless buildings with touch-free amenities. Renters and homeowners are discovering their homes and apartments virtually or through self-guided tours to limit touch.

Property owners will still need to make rapid structural changes. As more people work remotely, having access to high-speed internet will become more important, and properties will be among the first to implement broadband networks. Developers should know how to build reserved office spaces rather than flexible floor plans to optimize room for work and liveability. The mailroom in apartment complexes may be replaced by solutions such as in-unit delivery as internet shopping, and home deliveries become more popular.

COVID-19, along with a host of other long-overdue trends, is hastening the acceptance of smarter urban living (Meyers, Williams, and Matthews, 2010).

The role of apartment complexes and building managers in advancing creativity in response to COVID-19 is critical. Smart parking and contactless access are being imagined by building planners today in the same manner as larger hallways and better ventilation were envisioned in the past.

Landowners and technology pioneers have the chance to rethink how city dwellers will survive in the post-pandemic future, and some of these developments are still underway.

PROPOSED RECOVERY PLAN

Base on the literature reviews, all recovery housing is residential and emphasizes peer support (within the house, as well as through participation in mutual-help groups). Few are licensed treatment programs or staffed by licensed or certified behavioural health professionals. A hallmark of recovery housing is the value placed on experiential knowledge. Some types of residences (e.g., Oxford Houses) are entirely peer-led. Because the majority of recovery residences operate in the periphery of the formal substance use treatment system (both public and private), there are few formal third-party-payer systems set up to reimburse or offset costs of this service, leaving individual residents to pay most of the expenses. As residents are paying out-of-pocket, there are inherent pressures to keep operating costs down by increasing the number of residents per house or by relying on residents or other volunteers to maintain the

residence. There are also limited funds for emergency expenses. Lack of space to socially distance and isolate residents, limited staffing to sanitize the residence and enforce Centres for Disease Control and Prevention (CDC) guidelines, and a lack of funds for personal protective equipment could increase the risk of infection among residents (Mericle et al., 2020). Therefore, this study proposed a six-step recovery plan that can help to assess the current pandemic impact on housing plans and reduce the expense and delay impacts presented in Figure 2.

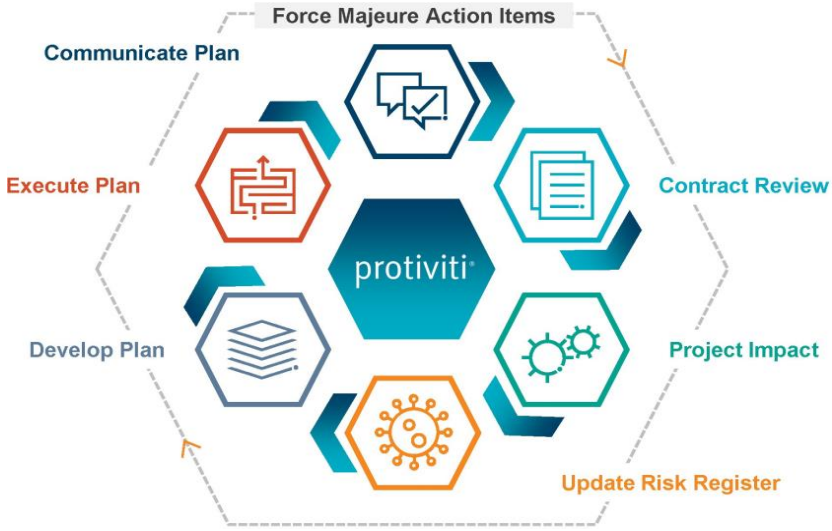

Figure 2 six-step recovery plan Source: (CIRT, 2020)

Critical review: Examine and classify contract terms to determine which conditions and relief entitlements apply to the present pandemic. The purpose of a force majeure clause is to protect a contractor from unavoidable and unforeseeable events beyond his or her control. Clauses that are silent on pandemics or don't mention virus outbreaks may be inadequate to justify COVID-19 as a force majeure argument. COVID-19 can be analysed in view of the contract's terms to see whether it counts as a force majeure case. If the provision is not applicable, a conversation between the owner and the contractor is required to formulate a project strategy for the present pandemic.

Project impact: If the owner has granted a force majeure petition, the contractor must prove that the COVID-19 pandemic has caused losses. A project's impacts can be categorized into five categories:

a. **Cost:** COVID-19 losses can be tracked separately, with expenses and performance hurdles measured. The cost analysis can be calculated depending on the scale of the project that would be affected. Job, idle machinery, general weather, and external protective steps such as thermal measurements, staff monitoring, and facility maintenance are all examples.
b. **Schedule:** Assess and calculate the amount of time spent unused, the expense accrued to date, and the scheduling delays caused by this occurrence. The contractor should determine the current scenario and adjust the timetable to incorporate the latest operation late-start and late-finish dates and the revised project completion date.

c. **Resource:** Assess the availability of resources as a result of illness and social distancing rules.
d. **Logistic:** Determine the effect on material, shipping, and essential component lead times.
e. **Quality**: Assess the effect on completion; trade/trained workforce shortages, and skilled resource travel restrictions.

Update risk register: Following the pandemic, the owner and contractor can recognize potential threats, delegate ownership, and develop a contingency strategy to resolve the risk elements to complete the project successfully. COVID-19 arose as an uncertain danger without the requisite controls in place to minimize it. Now that COVID-19 has arrived, the responsible party has a clear view of the current situation and should outline a contingency strategy for COVID-19-related threats so that the project can be finished.

Develop Plan: The fourth step is to create a plan that includes visibility into how the remaining project activities will be carried out

Execute Plan: The fifth step is to guide and coordinate the project work by introducing the accepted improvements to satisfy the needs of the stakeholders and meet the project's goals.

Communicate Plan: One of the most critical factors in maintaining stakeholder loyalty and buy-in for the strategy heading forward is collaboration. A structured notification schedule, tiers of notification, and frequency should be identified in this phase. A coordination plan's goal is to meet the established plan's objectives while still communicating the success of implementation.

In addition to the rehabilitation road map, health and safety management efforts would put more pressure on facility operators with testing and prevention steps to ensure that people working at or attending the property are not vulnerable to any health risks. The following are some of the immediate accommodations being made:

• Hand sanitizer stations should be installed.
• Paying for extra garbage disposal
• Displaying CDC posters highlighting the importance of handwashing and wearing masks.
• Requiring everyone entering and leaving the facility to undergo thermal screening (i.e., temperature checks using a digital thermometer)
• Installing disinfection devices, such as ventilation systems or UV lighting

CONCLUSION

This study did analyse the impact of pandemics on housing sectors via a concise literature review and how the players in the building sectors are overcoming the challenges posed to all capital investments which have benefits and drawbacks. However, without a reference to pandemics in the unforeseeable plan, the announcement of a pandemic by WHO followed the immediate termination and delays of many housing projects worldwide. COVID-19 did affect the housing industry, and how owners and contractors reacted to the effect of COVID-19. The study also investigates the correlation between past pandemic with present COVID-19 to identify the building sectors and suggest the possible solution to overcome such challenges. The project impact during the pandemic which is categorized as a *force majeure* petition, which the stakeholders in the building sector needed to prove that the COVID-19 pandemic has caused and possible highlighted as*; cost, schedule, resource, logistic and quality.*

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Risk Assessment of Safety for Building Construction Projects in Abuja, Nigeria

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Abstract:

The construction industry is considered as one of the most hazardous industries, with very high rate of accidents and ill-health problems to workers, organisations, society and countries. Fatalities, injuries and unsafe work conditions reported on construction sites are owing to contractors neglecting the risk involved in the construction activities that have the potential to cause injuries the most on site due to cost saving attitude. The study's objective is to assess the safety risk level for each work item, in terms of severity and probability on building construction projects in Abuja, Nigeria. 50 copies of well-structured questionnaires were administered to seek the opinion of construction professionals who managed and supervised construction projects in Abuja and 34 were returned representing a response rate of 68%. The data were analysed using Mean value method and prioritization number. The result on probability risk of occurrence (PRO) reveals that roof work and steel structure, with PRO of 3.15 and 3.05 are the building activities with medium risk level. While the result on severity risk impact (SRI): Electrical works, Steel structure, Roof work and Lift installation with SRI of 3.30 and 3.10 are the building activities with medium risk level. Safety risk prioritization result revealed that Roof work, Steel structure and Electrical works had the greatest risk level with an average risk score of 9.77, 9.46 and 9.14 respectively. It was concluded that though findings showed that most building construction activities in Abuja are of medium risks, but workers are still prone to injury and accidents which are tolerable. It is recommended that proper risk identification and prioritization should be a precondition for effective risk control on construction sites. The study provided an avenue for construction managers to identify the risk level of major construction activities which will assist them allocate safety measures in a more efficient manner.

***Keywords**: Construction projects, Hazards, Risk Assessment, Risk matrix, Safety Risk*

INTRODUCTION

The construction industry has a great influence on both the economy and social policies in many developing countries (Yoon *et al.*, 2013; Bilir & Gurcanli, 2018). Despite its socio-economic importance, the construction industry is considered as one of the most hazardous industries, with very high rate of accidents and ill-health problems to workers, organisations, society and countries (Muiruri & Mulinge, 2014; Sanchez *et al.*, 2017). The industry has a significant impact on the health and safety of workers. Construction workers perform a great diversity of activities, each activity with a specific associated risk. A worker is directly exposed to risks associated with task undertaking and passively exposed to risks produced by co-workers (Pinto *et al.*, 2011).

Accidents and fatalities at the construction sites results in numerous injury and death of worker yearly. According to the International Labour Organisation (ILO) there are 270 million occupational accidents resulting in two million deaths annually (Tadesse & Israel, 2016). ILO (2012) acknowledged that construction industry contributes 25 - 40% of the world's occupational fatalities. The Bureau of Labour Statistics (2016) reported that the fatality rate of the construction industry was 10.1 fatalities per 100,000 workers, which was higher than that of other industries, such as forestry 0.91, transportation 0.75 and fishing 0.24 fatalities per 100,000 workers. In the United States, the construction industry accounted for 19% of the overall industrial deaths in the year 2016 and globally the construction industry was found to

have higher fatality rate than in other industries (Chan *et al*., 2018). In the United Kingdom, the death rate of the construction industries was 1.37 fatalities per 100,000 workers, which was more than thrice higher than the average of all other industries (Health and Safety Executive, 2017). A study carried out by Hamalainen *et al.* (2009) puts the annual work-related death rate of Nigeria at about 24 fatalities per 100,000 employees. The situation in developing countries like Nigeria is worse than what prevails in developed countries, this is due to lack of statutory regulations on health and safety and lack of accurate records of accidents and injuries on site by contractors (Idoro, 2011).

Fatalities, injuries and unsafe work conditions reported on construction sites are due to contractors committing little resources to the maintenance of a healthy and safe construction work environment due to cost saving attitude, thus neglecting the risk involved in the construction activities that have the potential to cause injuries the most on site (Idoro, 2011; Windapo, 2014). Owing to this fact, it is of fundamental importance for construction companies to assess the risks at the work site and to take effective measures to minimize these risks. This can be achieved through a holistic approach by carrying out a study to assess safety risk level on building construction projects in Nigeria. The study's objective is to determine the level of risk for each work item, in terms of probability and severity on building construction projects in Abuja.

Risk Assessment

Baranda and Usmen (2006) defined risk as the measure of both the likelihood and the consequence of hazard associated with an activity or condition. Hallowell *et al.* (2017) described risk as a potential event that results in an outcome that is different from what is planned. In construction safety risks are defined as potential incidents. Risk assessment is described as a method used to decide on the priorities and to set objectives for eliminating hazards and reducing risks (Hughes & Ferret, 2016). Health and safety risk assessment on construction site is an important measure towards the reduction of hazards and injuries (Kozlovska & Strukova, 2012)**.** Identification of potential hazards and evaluating the risk associated with the hazards is an important step toward safety risk assessment (Aminbaksh *et al.*, 2013). According to Carter and Smith (2006) determining the risk for construction hazards depends on the probability of an accident occurring and the severity of the impact. Probability or frequency defines the likelihood or rate of occurrence of an accident or hazards in a specific period of time. In terms of safety risk probability of an accident is expressed in the form of an incident rate such as the number of worker-hours per incident (Hallowell *et al.* (2011). Severity defines the magnitude of the outcome. Severity may be defined in terms of the degree of injury (such as fatality, lost work-time and medical-case) or numerically in terms of money impact to the organisation (Hallowell *et al.*, (2017).

Research on safety risk assessment have different dimensions resulting in a great variety of units ranging from high level studies that compared risk among trades (Brauer, 2005; Baraban & Usmen, 2006; Fung *et al.*, 2010). And to detailed studies which looked at specific work activities and the risk associated with specific trades/tasks (Everett, 1996; Jannadi & Almishari, 2003; Gangolells *et al.*, 2010; Zolfagharian *et al*., 2014; Gurcanli *et al.*, 2015 and Okoye, 2018). It was observed that most of the studies mainly focused on injury and fatality risks as individual issues and were based on either frequency or severity alone resulting in a less comprehensive

result. This study is based on quantifying the potential safety risk level of construction work items in terms of severity and likelihood.

The process of risk assessment consists of three distinct phases: identification of risks, risk estimation and risk assessment (Tixier *et al*., 2002 and Pino & Garcia, 2017). Safety risk assessment can be computed using qualitative, quantitative and semi quantitative method (Purohit *et al.*, 2018). In risk assessment, the risk matrix method is a semi-quantitative method. The semi-quantitative analysis uses descriptive scales to produce a more structured way of ranking risks according to their probability and severity (Purohit *et al.*, 2018). This is attained through a predefined scoring system which allows one to map a perceived risk into a category, where there is a logical and hierarchy between categories. The risk matrix is a table that comprises several categories of probability (frequency or likelihood) for its rows or columns and several categories of severity (consequences or impact) for its columns or rows (Zolfagharian *et al*., 2014). Risk value is determined by estimating the probability (likelihood) of occurrence (P) and the potential severity of hazardous event (S).

Risk value is expressed as: $R = P \times S$ (1)

Where: P= Likelihood of occurrence and S = Potential severity of harm.

The 5x5 risk matrix defines 5 classes of likelihood and 5 classes of severity in cooperates these classifications both in descriptive and quantitative features (Ceyhen, 2012). Each descriptive class for likelihood and severity has a corresponding quantitative value from 1 to 5. There are five categories of likelihood of risk occurrence which are: Rare, Remote, Occasional, Frequent, Almost and they take value from 1 to 5, respectively. In the same way, Severity of consequence is also categorized into five: which are Negligible, Minor, Moderate, Major, Catastrophic and they take value from 1 to 5, respectively (Workplace Safety and Health Council (WHSC), 2011). Risk are evaluated by multiplying the values for likelihood and severity, and as the result, risk values from 1 to 25 are produced in the combination of different categories of probability and severity of consequence. According to this risk categorization, risk categories are developed as, high having risk level of (13 to 25), medium high having risk level of (12 to 5) and low high having risk level of (1 to 4). The second classification of risks are made on the bases of risk acceptance. There are three categories in this meaning: acceptable, tolerable and non-acceptable. The correspondence of categories and their risk value is summarized in the subsequent part with the help of tables.

METHODOLOGY

Quantitative research approach was adopted for the study. Questionnaire survey was used for data collection. A survey is a positivistic methodology that draws a sample from a larger population in order to draw conclusions about the population (Collins *et al.*, 2007). A well-structured questionnaire was developed and distributed to respondents to seek the opinion of construction professionals who managed and supervised construction projects in Abuja. The study assessed the perceptions of respondents in determining the probability of occurrence (likelihood) and severity of risk impact (consequence) on construction projects in Abuja. A non-probability sampling technique known as convenience sampling technique was used in sampling the study's respondents. Collins *et al.* (2007) described convenience sampling technique as a sampling method that involves choosing from a sample that is not only accessible but also the respondents are willing to participate in the study. The study was such

that the respondents were asked questions based on the building construction projects they were found handling on site during the self-administration of the questionnaires. This explains why the data obtained were limited to 34 and invariably 34 construction projects were examined, due to the fact that only 34 of the respondents were willing to participate out of the 50 supposed construction projects sites with on-going projects. The unit of analysis was construction project handled by each respondent. The data collected were analyzed using the descriptive analysis.

Method of Data Collection

The questionnaire was developed to assess the safety risk level for each work item, in terms of severity and probability on building construction projects in Abuja, Nigeria**.** The questionnaire was divided into two parts. The first part captured information about the respondents' background which includes: Academic qualification and year of experience. The second part of the questionnaire concentrated on 17 selected common work activities for building construction projects, were chosen after literature review (Jannadi & Almishari, 2003; Brauer, 2005; Baraban & Usmen, 2006; Fung *et al.*, 2010; Gangolells *et al.*,2010; Zolfagharian *et al*., 2014; Gurcanli *et al.*, 2015; Okoye, 2018). Respondents were required to express their view, based on their perception on the severity of risk impact (consequence) and probability of occurrence (likelihood) on the identified work activities on a 5-point likert scale where (1) = Rare, (2) =Remote, (3) =Occasional, (4) = Frequent, (5) = Almost, for Likelihood of risk occurrence (probability of occurrence) and
(1) = Negligible, (2) = Minor, (3) = Moderate, (4) = Major, (5) = Catastrophic, for Severity of risk (consequence of impact)

Method of Data Analysis

The data were analysed using descriptive statistics which involved the use of Mean value and prioritization number. A semi-quantitative risk analysis was carried out to assess the severity (impact) and probability (likelihood) for each work item in the building construction projects.

Assessment of Probability or Likelihood

The mean value method as shown in equation 2 will be used to calculate the probability (likelihood) of risk occurrence.

$$PRO = \frac{\sum_{j=1}^{5} j \times N_j}{\sum_{j=1}^{5} N_j} \quad (2)$$

Where PRO= probability of risk occurrence; j= probability of occurrence rating scale (integer value between 1 and 5), and Nj =number of the respondents selecting the probability of occurrence equal to j.

The 5x5 matrix as shown in Table 1 will be used to identify the probability that hazard may cause injury or ill-health and rated in the order of 1-5 score.

Table 1 Categories for Probability of Risk Impact (Likelihood Classification).

Level	Probability (Likelihood)	Description
1	Rare	Not expected to occur but still possible.
2	Remote	Not likely to occur under normal circumstances.
3	Occasional	Possible or known to occur.
4	Frequent	Common occurrence.
5	Almost	Certain continual or repeating experience.

Source: Workplace Safety and Health Council (2011)

Assessment for Severity or Consequence

The Mean Value Method as shown in equation 3 will be used to calculate the severity of risk impact as shown below.

$$SRI = \frac{\sum_{k=1}^{5} k \times N_k}{\sum_{k=1}^{5} N_k} \quad (3)$$

Where SRI = Severity of risk impact; K= Impact rating scale (integer value between 1 and 5), and Nk =number of the respondents selecting an impact equal to k.

The 5x5 matrix as shown in Table 2 will be used to identify the most likely severity outcome of the possible injury or ill-health.

Table 2 Categories for Severity of Risk Impact (Consequence Classification).

Level	Severity	Description
5	Catastrophic	Fatality, fatal diseases or multiple major injuries.
4	Major	Serious injuries or life-threatening occupational disease (including amputations, multiple injuries, major fractures, acute poisoning, occupational cancer).
3	Moderate	Injury requiring medical treatment or ill-health leading to disability (including lacerations, burns, sprains, minor fractures, deafness, dermatitis, work-related upper limb disorders).
2	Minor	Injury or ill-health requiring first-aid only (including minor cuts and bruises, irritation, ill-health with temporary discomfort).
1	Negligible	Not likely to cause ill-health or injury.

Source: Workplace Safety and Health Council (2011)

Risk Categorization on the Basis of Risk Level

The degree of risk score is attained through risk prioritization number which invariably determines the level of risk, which are obtained by multiplying the probability and severity columns. This is computed using equation (4):

$$R = \frac{\sum PRO}{N} \times \frac{\sum SRI}{N} \quad (4)$$

Where PRO = Probability (likelihood) of risk occurrence, SR= Severity of risk impact and N= Number of items.

Risk rating requires rating the risk as high, medium or low, depending on likelihood of an activity to cause harm and how serious the harm might be. The risk rating or degree or risk and associated description of risk level are summarized in Table 3.

Table 3 Risk Prioritization Number and Risk Level of an Activity

Risks score scale	Risk level	Risk Acceptability
$1 \leq X \leq 4$	Low	Acceptable
$4 < X \leq 12$	Medium	Tolerable
$12 < X \leq 25$	High	Not acceptable

Source: Workplace Safety and Health Council (2011)

Where x = the actual risk score for the considering variable (work item).

RESULT AND FINDINGS

Response Rate of Questionnaire

In this study 50 questionnaires were administered and 34 were returned representing a response rate of 68%.

Analysis of Respondents' Profile

The section unveils the profile of the respondent by determining their professional qualification and years of experience. Data collected in this regard is presented in Table 4.

Table 4. Profile of respondents

Academic Qualification of respondent	**Frequency**	**Percent**
HND	6	17.65
Bachelor Degree	14	41.18
Post graduate	2	5.88
Master degree holders	11	32.35
PhD.	1	2.94
Total	34	100
Year of experience of respondent		
5-10	10	29.41
11-14	8	23.53
15-20	4	11.77
21 years above	12	35.29
Total	34	100

Source: Researcher's fieldwork 2021

Table 4 illustrates the academic qualification of respondents; the largest majority of respondents were 14 (41.18%) those who possessed Bachelor Degree. Next is Master Degree holders with 11(13.6%), following are respondents with Higher National diploma 6(17.65%) next are Post graduate with 2(5.88%) and the last in the list is PhD with 1(2.94). Based on their various levels of qualification attained, it can be assumed that the respondents were competent. The highest number of respondents were those with the working experience of 21yrs and above 35.29%. 29.41% of the respondents have 5yrs – 10yrs working experience, while 23.53% of respondents having above 11yrs – 14yrs working experience and 11.77% of respondents having above 15yrs – 20yrs working experience. The result can be concluded that their responses could be considered to be dependable as they should have adequate knowledge of activities associated with construction safety risk assessment.

Analysis of safety risk assessment

This section reveals the result of the analysis for probability of occurrence, severity of risk impact and safety risk prioritization. These results are presented in Tables 5-7

Table 5 shows the summary of risk analysis of probability of occurrence (PRO), result of the top five main work activities in building construction projects: roof work, steel structure, electrical works, Rebar & other metal works and lift installation with PRO of 3.15, 3.05, 2.77, 2.55 and 2.5 respectively.

Table 5 Analysis of the Probability of Common Activities in Building Construction Projects.

S/N	**Work item in building construction projects.**	**Probability (Likelihood)**	**Rank**
1	Roof work	3.15	1
2	Steel structure	3.05	2
3	Electrical works	2.77	3
4	Rebar & other metal works	2.55	4
5	Lift installation	2.50	5
6	Concrete work	2.41	6
7	Frameworks	2.23	7
8	Masonry	2.36	8
9	Cladding work	2.24	9
10	Excavation	2.23	10
11	Ceiling Finishing	2.14	11
12	General site works	2.14	11
13	Mechanical works	2.09	13
14	Plastering & painting	2.00	14
15	Floor works	1.91	15
16	Door& window	1.86	16
17	Landscaping work	1.71	17

Source: Researcher's fieldwork 2021

Table 6 Analysis of the severity of common activities in building construction projects.

S/N	**Work item in building construction projects**	**Severity (consequence)**	**Rank**
1	Electrical works	3.30	1
2	Steel structure	3.10	2
3	Roof work	3.10	2
4	Lift installation	3.10	2
5	Rebar & other metal works	2.60	5
6	Masonry	2.50	6
7	Cladding work	2.50	6
8	Mechanical works	2.50	6
9	Excavation	2.50	6
10	Concrete work	2.40	10
11	Frameworks	2.30	11
12	Ceiling Finishing	2.30	11
13	General site works	2.20	13
14	Plastering & painting	2.10	14
15	Floor works	2.00	15
16	Door& window	1.80	16
17	Landscaping work	1.60	17

Source: Researcher's fieldwork 2021

Table 6 shows the summary of risk analysis of severity of risk impact, result of the top five main work activities in building construction projects: Electrical works, Steel structure, Roof work, Lift installation and Rebar & other metal works with SRI of 3.3, 3.1 and 2.6 respectively.

Table 7 shows the result of safety risk prioritization of building construction activities, the result revealed that roof work had the greatest risk level with an average risk score of 9.77, this was followed by steel structure with an average risk score of 9.46 next in line was Electrical works with an average risk score of 9.14. While landscaping work are lowest with safety risk prioritization score of 2.74 having very low risk. The result shows that the greatest risk level of activities is of medium risk according to the risk rating value.

Table 7 Analysis of safety risk prioritization of building construction activities.

S/N	**Work item in building construction projects.**	**Severity**	**Probability**	**Average**	**Risk level**	**Rank**
1	Roof work	3.10	3.15	9.77	Medium	1
2	Steel structure	3.10	3.05	9.46	Medium	2
3	Electrical works	3.30	2.77	9.14	Medium	3
4	Lift installation	3.10	2.50	7.75	Medium	4
5	Rebar & other metal works	2.60	2.55	6.63	Medium	5
6	Masonry	2.50	2.36	5.90	Medium	6
7	Concrete work	2.40	2.41	5.78	Medium	7
8	Cladding work	2.50	2.24	5.60	Medium	8
9	Excavation	2.50	2.23	5.58	Medium	9
10	Mechanical works	2.50	2.09	5.23	Medium	10
11	Frameworks	2.30	2.23	5.13	Medium	11
12	Ceiling Finishing	2.30	2.14	4.92	Medium	12
13	General site works	2.20	2.14	4.71	Medium	13
14	Plastering & painting	2.10	2.00	4.20	Medium	14
15	Floor works	2.00	1.91	3.82	Low	15
16	Door& window	1.80	1.86	3.35	Low	16
17	Landscaping work	1.60	1.71	2.74	Low	17

Source: Researcher's fieldwork 2021

Fourteen out of the seventeen building construction activities sampled were medium risk making 82.35%, while three of the building construction activities making 17.85% where of low risk.

DISCUSION OF FINDINGS

The result on risk analysis of probability of occurrence revealed that roof work has the highest risk level with PRO of 3.15. Steel structure was ranked second with PRO of 3.05 and Electrical works was third with PRO of 2.77. While result on severity risk impact revealed that Electrical works had the highest risk level with SRI of 3.30. Steel structure, Roof work and Lift installation were ranked second with SRI of 3.10 respectively. Safety risk prioritization result revealed that Roof work had the greatest risk level with an average risk score of 9.77, this is in line with Baraban and Usmen (2006); Fung *et al.* (2010) and Okoye (2018) who identified roof work as a trade with frequent risk occurrence in construction. Steel structure was second, with an average risk score of 9.46, this is in line with Ghousi *et al.* (2018) who revealed that installation of Steel structure is a high-risk activity in building construction projects. Electrical works was third with an average risk score of 9.14, this is in line with Baraban and Usmen (2006); Gurcanli *et al.* (2015); Ghousi *et al.* (2018) who revealed that electrical works is one of the high-risk work activities in building construction projects. While landscaping work are lowest with safety risk prioritization score of 2.74 having very low risk. It was observed that 14 out of the 17 common building construction activities sampled were medium risk making 82.35%.

CONCLUSION AND RECOMMENDATIONS

The study determined the level of safety risk for building construction work item, in terms of probability and severity. The result of the study illustrates that different building activities have different levels of risk associated with them. This might be attributed to the differences in the types of activities and the approach of operations involved in different building work activity. This further indicates that there are building work activities associated with high risks which are unacceptable, medium risk which are tolerable, so also those associated with low risks

which can be acceptable. Findings from risk level assessment of building activities revealed that Roof work, Steel structure and Electrical works are the building activities with the highest medium risk activities in Abuja. It is suggested that different strategies should be applied in managing health and safety risks in construction across building activities.

It can be concluded that although findings revealed that most building construction activities in Abuja are medium risks, workers in building construction sites are still prone to injury and accidents which are tolerable. It is recommended that proper risk identification and prioritization should be a precondition for effective risk control and management, in addition adequate measures should be put in place to control and reduce the risk to an acceptable level.

Further study should be carried out in the identification of health and safety measures for mitigating the risk associated with each building construction activities. The study provided an avenue for construction managers to identify the risk level of major construction activities which will assistance them allocate safety precautions in a more efficient manner. The use of risk assessment techniques, which focuses on the prioritization of risk will provide necessary information for safety budgeting and planning for contractors as well as safety experts. It is anticipated that this study will improve construction safety by promoting stakeholder's awareness of safety hazards and associated risks during construction.

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Influence of Workforce Diversity on Employee Performance In Construction Firms In Abuja, Nigeria

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Abstract:

In every organization, employees are regarded as the most valuable assets as their activity is crucial to achieving organizational goals. However, due to the diverse composition of the Nigerian populace, employees come from diverse regions and backgrounds which play a significant role in the way they conduct their lives and behave on the job. Therefore, this study aimed at assessing the influence of workforce diversity on employee performance in construction firms in Abuja. Primary data was obtained through well-structured questionnaire and administered to the employees of Urban Shelter Properties, Abuja. Analysis of the data was carried out with the use of Mean Item Score (MIS). The study revealed that the most influential factors affecting employee performance are commitment, competency, and organizational support with MIS 4.71, 4.69 and 4.47 respectively. While, the most effective strategies for enhancing performance of a diverse workforce are modeling of good behaviour by executive management, training of employees on diversity awareness and sensitivity and reverse mentoring between old and young employees with MIS of 4.27, 4.24, 4.20 respectively. Thus, the study concluded that the workforce diversity has a significant positive effect on employee performance. Based on this finding, the recommended that construction firms should consider increasing the skills, competence and commitment of employees through adequate training and provides them with necessary support in order to improve their performance. Construction firms should formalize, implement and measure diversity policies that will build an inclusive workplace in order to reap the benefits of diversity.

Keywords: Construction Firms, Workforce Diversity, Employee Performance, Commitment, Training.

INTRODUCTION

The construction industry plays a critical role in the socio-economic advancement of various Nations globally (Usman *et al.*, 2014). This industry makes important contribution to the development process in developing countries, engaging a large part of the country's labour force and assisting in the enhancement or acquisition of skills (Bejide and Iyagba, 2015). In Nigeria, the construction industry is a wide range of loosely integrated organizations comprising of different professionals that collectively build, modify and repair series of building and civil engineering projects (Akanni *et al.*, 2015). According to Ukachukwu and Iheriohanma (2013), employees can be seen as a collection of individuals working in an organization to produce value (goods and services) under a contract of employment in return for wages. Employees can make or break the organizations reputation and can adversely affect productivity at such they can be seen as the most valuable assets of every organization (Sendawula *et al*., 2018). Employee performance is the degree to which an employee executes his or her duties and responsibilities (Shields, 2016). It is seen as how well an employee achieves his or her goals and objectives (Rath and Conchie, 2009). Yusuf *et al.* (2014) regard employee performance as the ability of an employee to meet set objectives within the scope of time and parameters.

According to Akinnusi *et al.* (2017), Nigeria is perhaps the giant of Africa in many respects. It is the most populous country with a projected over 180 million people, with multi-ethnic, multi-

religious and multi-cultural diversities. Thus, employees working for organizations may come from various diverse regions and backgrounds which play a significant role in the way they conduct their lives and behave on the job. Robbins and Judge (2013) refer to diversity as any characteristic that makes people different from one another. It is the differences and similarities amongst employees in terms of gender, age, educational background, ethnicity, sexual orientation, or other dimensions (Akpakip, 2017). Therefore, workforce diversity refers to organizations that are becoming more heterogeneous with the mix of people in terms of gender, age, race, and education background (Robbins and Judge, 2013). Diversity can affect the workplace in both positive and negative ways. It can lead to new innovations, knowledge sharing, knowledge enhancement and team coherent. While the problems it generates are miscommunication, creation of barriers, dysfunctional adaptation behaviours, discrimination, conflicts, prejudice and bias (Bamgbade *et al.*, 2014). Increasing globalization necessitates more interaction among individuals from diverse cultures, beliefs, and backgrounds than ever before. For this reason, diversity has become an essential requirement for organizations to be creative and exposed to change (Mazur, 2010). Organizations such as construction firms can not shy away from engaging diverse workers partly because skill is not evenly distributed between the various diverse tribes, regions and backgrounds, there is shortage of skill, hence the need to get the right person that will be able to carry out the work regardless of the region or tribe the person originates from. Managing these diverse workers is therefore paramount for the growth of the organizations that employed those employees (Loosemore *et al.*, 2012). This necessitates an assessment of the influence of workforce diversity on employee performance in construction firms in Abuja, Nigeria.

CONCEPT OF DIVERSITY

Diversity is an individual phenomenon generated by the members of a team themselves who base on their diverse social characteristics label others as similar or dissimilar. It is the combined, all-inclusive mix of social differences and similarities along any given dimension (Mazur, 2010). The study of Mazur (2010) further revealed that diversity is not only concerned with the effects of the diversity within an organization but also defines the level of honesty to diverse characteristics that exists between members of the organization, work groups, and culture. It does not only look at how individuals identify themselves but also how they categorize others. Diversity means different thing to different people. According to Otike *et al.* (2010), diversity can be defined as a mixture of individuals who bring a variety of backgrounds, perceptions, beliefs, and benefits as resources to the groups and organizations with which they work together. Dessler (2011) defines diversity as the collection of demographic features that describe a company's labour force, mainly in terms of race, sex, culture, national origin, handicap, age, and religion. Jones and George (2011) proclaim that diversity is dissimilarities among individuals in age, gender, race, ethnicity, religion, sexual orientation, socio-economic background and capabilities/disabilities. Diversity recognizes differences. On this basis, The Law Society of Scotland (2013) opined that diversity is purely concerned with recognizing that every individual possesses different visible and non-visible characteristics. Akinnusi *et al.* (2017) affirmed that diversity indicates the variety, variegation and collection of features, both observable and undetectable, which constitute a phenomenon in both the living and non-living worlds. Diversity also recognizes similarities. In this vain, The Society for Human Resource Management (2009) defines diversity as the combined mix of differences and similarities that cut across various dimensions such as individual and organizational characteristics, values,

beliefs, experiences, backgrounds, preferences and behaviours. According to Patrick (2010), the subject of diversity is important to every organization and they are predicted to become even more important in the near future due to increasing differences in the population of many countries. Hence, companies, organizations and firms looking to become more productive and competitive must direct their effort on issues of diversity to harness the potential benefit it offers.

DIMENSIONS OF DIVERSITY

Research into the concept of diversity has indicated three dimensions of diversity. These include; the primary differences such as age, gender etc., the **s**econdary differences such as educational background, communication style, etc. and tertiary differences such as beliefs and Group Norms (Akpakip, 2017).

Diversity in the context of age is seen as an integral part of various organizations. It is a common occurrence that exists in virtually all groupings, such as organizations, families, work or team groups composed of individuals identified with varying age generations (Kunze *et al.*, 2013). Rowe (2010) postulates that labour force is unique in its generational diversity. Thus each generation have confidence that their strengths are supreme over those of other generations. As a result of this, organizations are faced with emerging challenges when trying to attract, retain, manage and motivate quality employees. According to Rowe (2010), age diversity can benefit both the organization and the employees. He postulates further that work environments characterized with diverse employees of varying ages creates better working relationships and enhances social cohesion for all. Backes-Gellner and Veen (2009) affirmed that productivity and efficiency reduction, clashes and conflicts among employees are for the most times due to the existence of "generation gaps". The study of Zemke *et al.* (2013) refers to generation as a collection of people born and living as the same period, who have common attitudes, tastes, knowledge and experiences that affect their thoughts, values, beliefs and behaviors. Each generation have diverse perceptions and expectations that they bring to the work environment, perceptions of how they are to behave, how they will manage others and expectations of how they will be managed by their employers or managers. According to Powell (2011), gender is the physical interpretation of someone as either a male or female. Gender diversities are noticeable in prejudice, stereotypes, and discrimination. Powell (2011), states that the usual descriptions used for women's absenteeism in senior management roles has been that of the "glass ceiling". Glass ceiling defines specific organizational practices and processes that restrict women from attaining the highest position of their particular field only because they are women. Also, the average female employee working in most organizations does not only receive lower pay but also have an economic status that is lower than that of their male counterparts. This gap can be partly attributed to the lower average wages which workers in female intensive occupations receive. Powell (2011) further added that glass ceiling is not a barrier that is based on women's lack of ability to handle upper-level management positions. Instead, the barrier keeps women from climbing up the managerial ladder only because they are women. Removing these barriers remains a major challenge to most organizations worldwide. As a result, effective organizational policies that promote equality in pay and other benefits programs for women are needed in organizations.

According to Akpakip (2017), educational background is related to any type of official training, education or even career that an individual has learnt over time. Thus, educational diversity is defined as the range of individual's social and personal differences, which represent a basic

aspect in any educational setting (Rayner, 2009). The study of Akpakip (2017) revealed that it is common for people to have the opinion that educated employees can accomplish certain tasks easily, effectively and efficiently than those who are not. This simply means that an individual who is knowledgeable can perform better at tasks that require skills and knowledge. Daniel (2009) revealed that mobility rates largely depend on the type and level of education acquired. Based on Daniel findings, educational level plays a major role in determining an employee's performance. Furthermore, Hoff (2014) discovered that organizations found it difficult to employ workers who lack basic training, work experience, or required educational level to perform. This only affirms that education background is critical to employee's employability level. As such, employees cannot find a job and perform well without adequate education background. According to Emiko and Eunmi (2009), employee's productivity depends largely on the level of education they receive. The more education they receive, the more productive they are expected to be.

WORKFORCE DIVERSITY

Workforce diversity is connected to workforce, hence the need to first look at the word workforce. Rao and Bagali (2014) posits that workforce is a combination of male and female employees coming from various backgrounds, older or younger employees, workers who are physically challenged and various other workers who are different from each other.

Digressing from workforce-to-workforce diversity, Griffin and Moorhead (2014) defined workforce diversity as those major differences and similarities that exist among employees within an organization. Nwinami (2014) sees workforce diversity as that uniqueness which includes; an individual's personality, income, age, marital status, work experience, ethnicity/race, gender, religion and those views which supposes and sustains an organizations core value. It can also be seen as those organizations that are turning out to be more mixed with respect to its workforce composition based on characteristics as age, ethnicity, expertise, etc. (Robbins and Judge, 2013).

FACTORS INFLUENCING EMPLOYEES' PERFORMANCE

Employees are among an organization's most important resources and therefore seen as their most valuable assets. This is because the nature and quantity of work they execute have a direct impact on the productivity of an organization. The study of Rahman *et al.* (2011) reports that the performance of an employee can be determined based on the following three factors; work environment, ability and motivation. Thus, expressed by the formula; Performance = f (work environment x ability x motivation). In this context, ability refers to physical, emotional and intellectual capability of the employee to carry out his task. Robert *et al.* (2015) affirm that employee performance is founded on ability and motivation as the basic factors. Thus, in their own context, Performance = f (ability x motivation). They further added that the above formula is a means by which human resource management conceptualize the determining factors of employee performance. This means that if employee's motivation or ability is low, the subsequent effect will be that employee's performance will also be low. Robert *et al.* (2015) explained that Ability means competencies, commitment and self-efficacy (self-efficacy is a motivational factor and it is that believe that an employee has concerning his or her ability to perform the task assigned to him/her) while Motivation has to do with contingencies, goal-task clarity, feedback, system- technology, task interference opportunity and workplace layout. System factors include factors such as poor relationship among employees, lack of adequate training, etc. Motivation looks at the employee's desire and commitment to his job.

RESEARCH METHODOLOGY

Research and Data Collection

According to Eric, (2009) research design is the deliberate strategic approach used in conducting a scientific enquiry. This study adopts survey research design method using quantitative research approach. The study adopted primary source for it data collection using a well-structured questionnaire, while descriptive and inferential analysis were used for data presentation. According to Eric (2009), sampling Frame is a list of every member or unit of the population from which the sample will be drawn. The sampling frame for this study consists of Architects, Builders, Quantity Surveyors, Engineers, Project Managers and Administrative Staffs that makes up the entire population. The study adopted the entire population due to its size and as such sampling was not necessary. According to Masuku and Singh (2014), an entire population will have to be sampled in small populations (i.e. less than 100) to achieve a desirable level of precision. A total of 92 employees were adopted. Data analysis involves making sense out of the numerical values obtained through the data collection process (Eric, 2009). This research utilizes both the Descriptive and Inferential method of analysis. Descriptive analysis using Mean Item Score (MIS) was employed to identify and examine factors influencing employee performance in construction firms, and to examine strategies for enhancing the performance of a diverse workforce.

DATA ANALYSIS AND DISCUSSION OF RESULTS

This section gives the presentation of results of data collected from the analysis carried out. The data collected from the study were analysed using Mean Item score (MIS), Frequencies and Simple Percentages with the aid of Statistical Package for Social Science (SPSS) and were presented in Tables.

Table 1: Demographical Information of the Respondents' Survey

		Frequency	Percent (%)	Valid (%)	Cumulative (%)
Age (years)	18 - 30	22	34.9	34.9	34.9
	31 - 40	16	25.4	25.4	60.3
	41 - 50	17	27.0	27.0	87.3
	51 and above	8	12.7	12.7	100.0
Gender	Male	42	66.7	66.7	66.7
	Female	21	33.3	33.3	100.0
Profession	Quantity Surveyor	10	15.9	15.9	15.9
	Architect	8	12.7	12.7	28.6
	Builder	7	11.1	11.1	39.7
	Engineer	11	17.5	17.5	57.1
	Project Manager	8	12.7	12.7	69.8
	Admin Staff	19	30.2	30.2	100.0
Academic Qualification	ND/NCE	7	11.1	11.1	11.1
	HND	11	17.5	17.5	28.6
	B. Sc./ B. Tech	28	44.4	44.4	73.0
	M. Sc	16	25.4	25.4	98.4
	PhD	1	1.6	1.6	100.0
Experience	0-5	19	30.2	30.2	30.2
	6-10	22	34.9	34.9	65.1
	11-15	14	22.2	22.2	87.3
	16-20	8	12.7	12.7	100.0

Table 2 revealed ten (10) basic factors influencing employee's performance with mean score ranging between 4.71 and 3.01.

Table 2: Factors Influencing Employee's Performance

S/N	Factors Influencing Employee's Performance	MIS	Rank	Decision
1	Commitment	4.71	1st	Very Influential
2	Competency	4.69	2nd	Very Influential
3	Organizational Support	4.47	3rd	Influential
4	Task Clarity	4.41	4th	Influential
5	Relationship with other employees	3.98	5th	Influential
6	Self Confidence	3.89	6th	Influential
7	Emotional state of mind	3.62	7th	Influential
8	Task Interference Opportunity	3.40	8th	Fairly Influential
9	Workplace Layout	3.21	9th	Fairly Influential
10	Feedback	3.01	10th	Fairly Influential

"Commitment'' had a mean score of 4.71 and was ranked first, followed by "Competency'' which was ranked second with a mean score of 4.69, "Organizational support'' with a mean score of 4.47 was ranked third, "Task clarity'' ranked fourth with a mean score of 4.41, "Relationship with other employee's'' with a mean score of 3.98 was ranked fifth while "Feedback" was the least on table of ranking with a mean score of 3.54. This finding agreed with research result under taken by Robert *et al.* (2015) who explained that employee performance is founded on his or her competency, commitment and self-efficacy.

Table 3: Relationship between Age Diversity and Employee Performance

S/N	Relationship between Age Diversity and Employee Performance	MIS	Decision
1	We include all members of different ages in decision making and problem solving	3.63	Agreed
2	Older people have more experience and possess better problem-solving skills	4.20	Agreed
3	This organization provides all age groups with equal opportunities for training and career development	4.22	Agreed
4	I have no problem working with people of different age groups	3.90	Agreed
5	Age difference in work group might cause conflict	3.38	Neutral

Table 3 presents the relationship between age diversity and employee performance. The respondents agreed with a mean of 3.63 that they include all members of different ages in decision making and problem solving. They also agreed with a mean of 4.20 that older people have more experience and possess better problem-solving skills. This finding agrees with the study of Akpakip (2017) who affirmed that older employees contribute a lot to the team due to the knowledge and experience they have accumulated over the years. However, it disagrees with the findings of Robbins and Judge (2013) which postulates that it is a common believe that as people get older, their physical ability, speed and coordination starts to decline and job could become boring and the absence of intellectual motivation all contributes to reduced productivity. Further, the respondents agreed with a mean of 4.22 that the organization provides all age groups with equal opportunities for training and career development.

Table 4: Relationship between Gender Diversity and Employee Performance

S/N	Relationship between Gender Diversity and Employee Performance	MIS	Decision
1	Women are involved in the organization's decision-making process as much as men	4.40	Agreed
2	Opportunities for growth and advancement exist for both men and women in our organization	3.94	Agreed
3	Dissimilarity in gender leads to poor employee performance	2.17	Disagree
4	At work, I experience lack of bonding with the opposite gender	1.84	Disagree
5	At work, I find it difficult to take instructions from the opposite gender	2.57	Neutral

Table 4 presents the relationship between gender diversity and employee performance**.** The respondents agreed with a mean score of 4.40 those women are involved in the organization's decision-making process as much as men. They also agreed with a mean score of 3.94 those opportunities for growth and advancement exist for both men and women in their organization. Further, the respondents disagree with a mean of 2.17 that dissimilarity in gender leads to poor employee performance. This finding agreed with the study of Kirton and Greene (2016) which opined that gender diverse groups are most likely to make quality decisions much more than a homogeneous workforce.

Table 5: Relationship between Educational Background Diversity and Employee Performance

S/N	Relationship between Educational Background Diversity and Employee Performance	MIS	Decision
1	The difference in educational background does not encourage conflict	3.05	Neutral
2	Diversity in education brings about creativity and enhance our task delivery	4.43	Agreed
3	My educational level and background affect my ability to perform my core task responsibility	4.40	Agreed
4	The recruitment plan of the organization is based on the education diversity of the employees	4.30	Agreed
5	We include all members at different educational level in decision making and problem solving	4.40	Agreed

Table 5 presents relationship between educational background diversity and employee performance the respondents were neutral on whether difference in educational background does not encourage conflict with a mean of 3.05. The respondents agreed with a mean score of 4.43 that diversity in education brings about creativity and enhance task delivery. Similarly, the respondents agreed with a mean of 4.40 that their educational level and background affects their ability to perform their core task responsibility. In addition, the respondents also agreed with a mean of 4.30 that the recruitment plan of the organization is based on the education diversity of the employees. Further, the respondents also agreed with a mean score of 4.40 that they include all members at different educational level in decision making and problem solving. This finding was in tandem with the report of Akpakip (2017) who revealed that educational background of workers can also have significant positive effect on performance as it allows for collection of different capabilities and talents within a workforce.

Table 6: Employee Performance

S/N	Employee Performance	MIS	Decision
1	I enjoy my tasks and the division's work approach	4.43	Agreed
2	I am committed to the mission and direction of my organization	4.40	Agreed
3	I am motivated to complete the task that is assigned to me	4.30	Agreed
4	Despite all differences, I co-operate well with my colleagues	4.40	Agreed
5	I am given the chance to try my own method of doing the job	3.73	Disagree

Table 6 presents the employee performance. The respondents agreed with a mean of 4.43 that they enjoy their tasks and the division's work approach. The respondents also agreed with a mean of 4.40 that they are committed to the mission and direction of their organization. Further, the respondents agreed with a mean of 4.30 that they are motivated to complete the task that is assigned them. In addition, the respondents agreed with a mean score of 4.40 that they co-operate well with their colleagues despite all differences. Lastly, the respondents agreed with a mean of 3.73 that they are given the chance to try their own method of doing the job. These findings agree with Magoshi and Chang (2009) that workplace diversity influences employee motivation and commitment positively.

Table 7: Strategies for Enhancing Performance of a Diverse Workforce

S/N	Strategies for Enhancing Performance of a Diverse Workforce	MIS	Rank	Decision
1	Executive management should model good behaviour	4.27	1st	Effective
2	Adequate diversity awareness and sensitivity training of all employees	4.24	2nd	Effective
3	Managers should encourage reverse mentoring between old and young employees	4.20	3rd	Effective
4	Measuring and reporting diversity performance through surveys	4.08	4th	Effective
5	Offering flexible employments that enable employees to have a balance between work, family and religion	3.57	5th	Effective
6	Management should create a diversity portfolio such as Chief Diversity Officer to lead diversity initiatives	3.11	6th	Fairly Effective
7	Increasing the representation of women and minorities in the recruitment and selection of staffs	2.97	7th	Fairly Effective
8	Organizing diversity integration opportunities where employees share their cultural and religious beliefs	2.81	8th	Fairly Effective
9	Developing a diversity dictionary to provide insights and quick information about different groups	2.46	9th	Less Effective
10	Incorporating religious and cultural holidays for a day that is of cultural significance to the employees	2.40	10th	Less Effective

Table 7 revealed ten (10) basic strategies for enhancing performance of a diverse workforce with mean score ranging between 4.27 and 2.40. Strategies such as “Executive management should model good behaviour’’, “Adequate diversity awareness and sensitivity training of all employees’’ and “Managers should encourage reverse mentoring between old and young employees’’ were ranked first, second and third with a mean score of 4.27, 4.24 and 4.20 respectively. “Measuring and reporting diversity performance through surveys’’ ranked fourth with a mean score of 4.08, “Offering flexible employments that enable employees to have a balance between work, family and religion’’ with a mean score of 3.57 ranked fifth, while the least on the table of ranking was “Incorporating religious and cultural holidays for a day that is of cultural significance to the employees’’ tenth with a mean score of 2.40. These findings were in tandem with the study of Mor-Barak (2014) who identified employee training, cultural audit and recruitment considerations among the top human resource approaches to managing workforce diversity.

SUMMARY OF FINDINGS

The analyses carried out in this study revealed the following:

i. The most influential factors affecting employee performance are commitment (MIS=4.71), competency (MIS=4.69) and organizational support (MIS=4.47).

ii. The most effective strategies for enhancing performance of a diverse workforce are modeling of good behaviour by executive management (MIS=4.27), training of employees on diversity awareness and sensitivity (MIS=4.24) and reverse mentoring between old and young employees (MIS=4.20).

CONCLUSION

In every organisation, employees are regarded as the most valuable assets as their activity is crucial to achieving organisational goals. However, due to the diverse composition of the Nigerian populace, employees come from diverse regions and backgrounds which play a significant role in the way they conduct their lives and behave on the job. The study assessed the influence of workforce diversity on employee performance in construction firms with a view of providing strategies for enhancing the performance of a diverse workforce. However, the study has revealed that the most influential factors affecting employee performance are commitment, competency and organizational support. The analysis disclosed that the most effective strategies for enhancing performance of a diverse workforce are modelling of good behaviour by executive management, training of employees on diversity awareness and sensitivity and reverse mentoring between old and young employees. Finally, workforce diversity has a significant positive effect on employee performance.

RECOMMENDATIONS

The findings of this study led to the following recommendations:

i. Construction firms should consider increasing the skills, competence and commitment of employees through adequate training and provides them with necessary support in order to improve their performance. Construction firms should formalize, implement and measure diversity policies that will build an inclusive workplace in order to reap the benefits of diversity.

ii. Construction firms should model good behaviour, train employees on diversity awareness and sensitivity and encourage reverse mentoring between old and young employees in order to enhance the performance of a diverse workforce.

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SUB-THEME 2:

ACCESS TO FINANCE FOR HOUSING AND LAND DEVELOPMENT

Energy Pricing and Poverty in Sokoto City, North West Nigeria: A Lesion in Green House Gas Reduction

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Abstract:

Energy policies and reforms have been pursued differently by societies on the basis of spatial and socio-economic peculiarities. Nigeria's response in this regard manifests through different intervention strategies at different scales. A number of these strategies are aimed at promotion of relatively less violent sources of energy. This paper examined the nexus between climate change mitigation and adaptation efforts on one hand, and energy as well as income poverty on the other. Using the end-use method, monthly electrical energy consumption for average household in the city of Sokoto was established under the Business as Usual (BaU) and ideal scenarios, assuming a 30-day month. The results indicated an average consumption of 137.7 kWh and 303kWh for BaU and ideal scenarios respectively. The percentile method was used to disaggregate the income classes. The lowest expenditure (i.e., for income class in the lower percentile) even under the BaU scenario was found to be 12.85%. The use of LPG for cooking was found to have improved in the city from 0.2% in 2010 to 17.5% in 2019. By implication, even on the basis of the BaU scenario for electricity supply in Sokoto, the average established cost by far exceeds the World Bank's upper limit of 3.8% for low-income households in developing countries. Also, even though Income poverty and Energy poverty are two different things, they are still related as highlighted previously by other researchers. In the context of Sokoto city, almost all income poor households tend to be energy poor (which is a general case in most developing countries), as the lowest proportion of income spent on electricity for low-income households stood at 12.85% which more than tripled the threshold value. However, about 50% of the energy poor households are not income poor. This of course constitute a lesion for successful efforts in reducing greenhouse gas emissions.

***Keywords**: Energy, Sustainability, Poverty, Pricing, Climate change, Environment*

INTRODUCTION

Nigeria is one of the countries with very little to no climate change policy in place even though the country is expected to be a leader in Africa in the global push for greener environment by encouraging the use of sustainable energy sources and provision of clean cooking facilities (ScoreCard, 2016). Little has been done to achieve item number seven of the Sustainable Development Goals (SDGs) agreement put forward in 2015 "sustainable energy for all". Africa's largest producer and exporter of crude oil, largest economy with over 200 million people, yet sustainable growth has remained a fantasy since independence in 1960. About 94% of the population do not have access to clean cooking facilities and 39% of the population is off grid, they do not have access (in terms of availability) to electricity (Dioha & Emodi, 2019). The lingering nature of the energy crisis as a result of social, economic and geopolitical challenges coupled with corruption in almost every sector of the government has worsened since the huge inflow of oil income in the mid-1970s, despite huge investment of public funds in an oil industry largely controlled by the government (Iwayemi, 2008). Inconsistent government policies, uncertainty in the political system, inadequate security and corrupt judiciary system have nullified the nation's efforts towards achieving sustainable growth (Baba, Achoba, & Otaro, 2015; Kende-Robb, 2015). Energy is an essential element for the socio-economic development and wellbeing of a society. Energy poverty, climate change and food security which are some of today's global issues, can be addressed by providing

sustainable, adequate and affordable energy service (Dioha & Emodi, 2019). According to Alkali (2016), cited in (Ehirim, 2016) Nigeria did not endorse the Paris agreement in 2015 let alone meeting a pledge. This according to (Alkali, 2016), was because Nigeria did not consider the agreement to be important and that, some Nigerians consider the agreement to be retrogressive to country's development efforts. Either way, previous efforts to achieve item 7 of the SDGs (eliminate energy poverty) in Nigeria could not deliver the much-expected result (considered too ambitious by many) in terms of effectiveness and pace. Consequently then, the Sustainable Energy For All (SE4ALL) initiative which was put forward by the United Nation (UN) in 2010 to ensure access to sustainable energy for all by 2030 remained a fantasy.

Energy Sector and the Nigeria's Economy

The most important sector of Nigeria's economy is the energy sector and this sector plays a critical role relative to other sectors of the economy. It is the sector with the most direct and immediate effect on the socio-economic wellbeing of the people. This is obvious when one takes a closer look within the last decade at how the price of petroleum-based goods increased with changes in energy policies (like petroleum supply and its price as a result of the subsidy debate) as well as how increase in power pricing affected the Industrial sector. With all the important role the energy sector is expected to play, this sector is arguably the most inefficient in meeting the needs of its customers in the entire world. As a result, Nigeria's persistent energy crisis has crippled the industrialisation process and almost if not completely, nullified the efforts to achieve sustainable growth.

Despite being a leading exporter of Liquefied Natural Gas (LNG) (Figure 1, around 25 billion m^3), inadequate gas supply is unfortunately the dominant factor for the frequent system collapse in a gas-dependent electric grid.

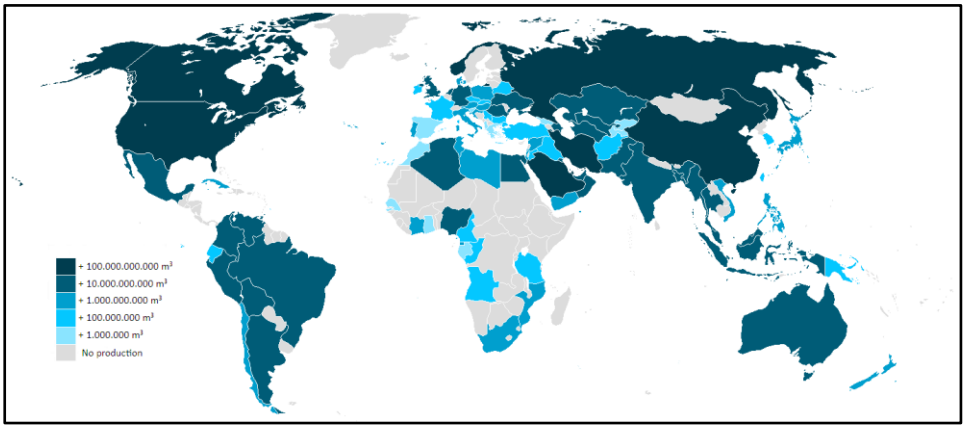

Figure 1: Distribution of World's natural gas reserves.

Source: (IEA, 2018)

The insurgency in the oil-rich Niger Delta region which result in pipeline vandalization has worsened the electricity supply problems. On top of all that Nigeria is unnecessarily, consistently put among the countries with the largest amount of carbon emission largely due to unrestrained but controllable gas flaring (Iwayemi, 2008). People with enough income were left with no choice other than to substitute the poor supply and delivery of electricity with highly polluting electric generators. Inadequate supply of natural gas in some parts of the

country promoted the use of carbon intensive energy sources such as kerosene and wood fuel. The increase in the price of kerosene as a result of scarcity promoted the use of wood fuel for cooking to a greater extent even with its adverse environmental effect. Though many policies were set in the past with respect to the supply of natural gas, many of such policies were not implemented properly. One example is the Gas Master Plan (GMP) designed to ensure the development of a fully effective domestic market by 2015. The policy did not provide the much-anticipated result because Nigeria was still lacking the adequate gas infrastructure and continue to fall short of domestic gas supply obligations towards the turn of the target year (Resources, 2017). In the gas policy of 2017 (Resources, 2017) it was clearly stated that one of its objectives was to prioritise domestic usage of LPG especially in the electricity sector (which is the major consumer of LPG), but inadequate gas supply is still a major challenge to the gas dependent electricity sector. That is why natural gas consumption per capita in Nigeria is still one of the least globally.

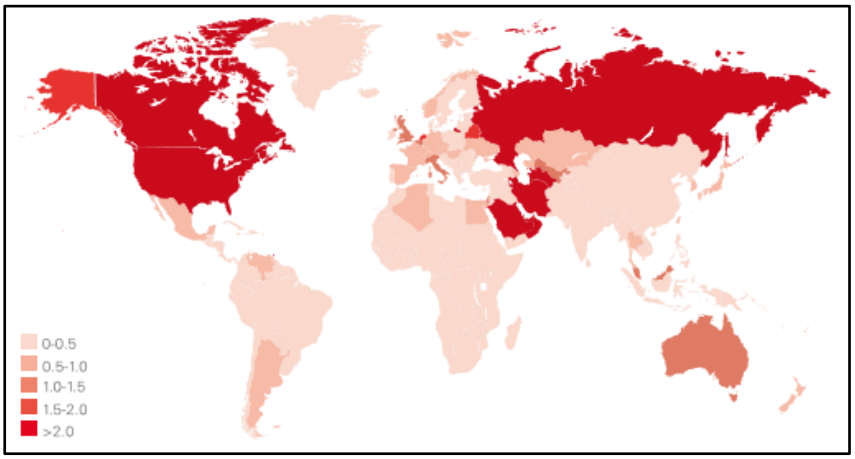

Figure 2: Natural-gas-consumption-per-capita-2018
Source: (Energy, 2019)

Energy and Income Poverty in Sokoto City

Extreme poverty is still a development challenge in Nigeria, 53.5% of the population was estimated to be poor in 2009 (Bank, 2018). In 2018, poverty was projected at 50 percent indicating little improvement in incomes of the bottom half of the population over the past decade. Since the sharp decline in oil prices in late 2014 and the subsequent slowdown of the economy, Nigeria has struggled to revive economic growth. Though growth weakly rebounded in 2017, it was still inadequate, because unemployment and underemployment were still high, each affecting over 25 percent of the labour force. Additionally, high inflation continues, especially food inflation, which disproportionately affects the poor since food constitute almost 70 percent of their expenditure (Bank, 2018). Another challenge to poverty reduction is insecurity, especially in the north-eastern part and even some places in the north-western part of the country. This has resulted in low agricultural production, migration, and obstruction in the provision of basic amenities. There is significant disparity between the north and southern part of the country because the spread of poverty is largely in the north (where the area under

study is located), as much of the population lives in rural areas dependent largely on subsistence farming.

Energy poverty can be defined as lack of access (unavailability/unaffordability) to modern energy services. In most developed countries however, lack of affordability is a more proper definition, which is regarded as difficulty for households to pay for their domestic energy services (Grave et al., 2016; Jones & Lomas, 2015). In the course of this study, energy poverty will be taken as lack of availability which is the definition used by previous researchers in Nigeria.

The section that follows will give us a better picture of how to define energy poverty in the context of Sokoto city. Lack of access to Electricity happened to be a more pressing issue in the northern part of Nigeria especially the north-western and the north-eastern parts. As shown in Figure 3, electricity access by percentage is higher in the southern part of the country. As depicted in figure 3, less than 30% have access to electricity in Sokoto in 2012.

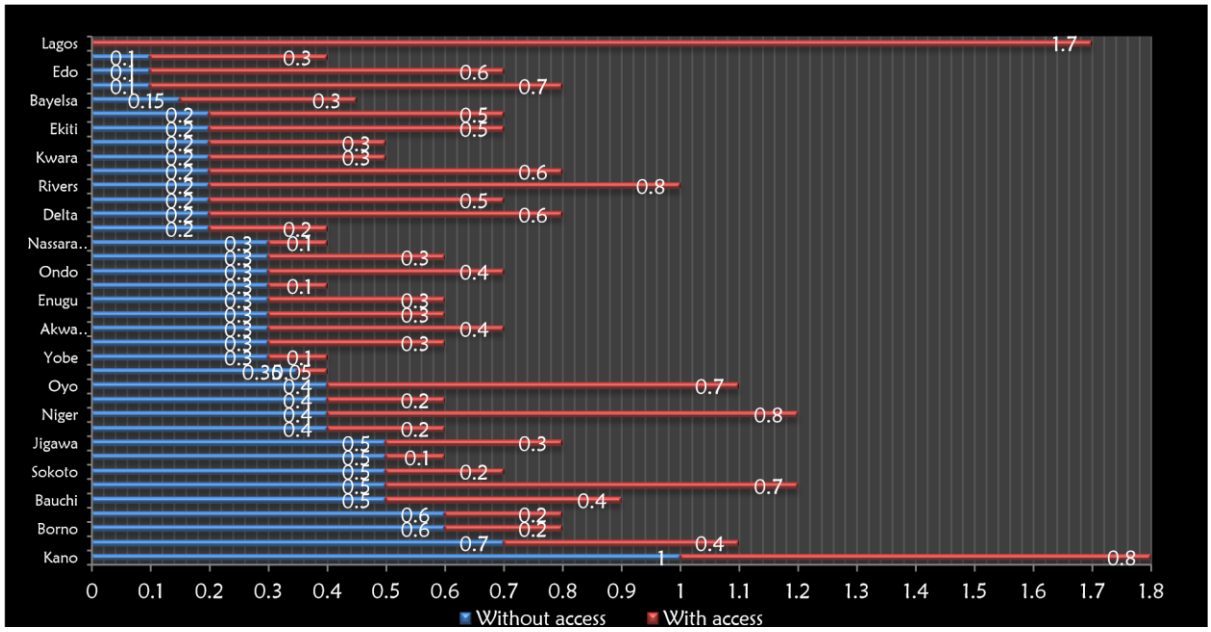

Figure 3: household electricity access by state (x million)

Source: IFC 2011 (cited in (Eleri, Ugwu, & Onuvae, 2012)

The supply of natural gas is more evenly distributed than electricity, still Sokoto is one of the least in the country in terms of LPG usage for cooking, with an estimated 0.2% of the population using LPG for cooking in 2010. A more recent statistics was reported by (Ahmed, 2015) shows that 5% of the Nigerian household energy mix is from gas as at 2013, and the use of wood fuel was estimated to be 64% as shown in Figure 4.

It is worth knowing that it is more time and effort consuming to collect the same amount of wood in the north than in the south where it is more available, and that cutting down of trees (which is the primary source of wood) is more damaging to the northern physical environment.

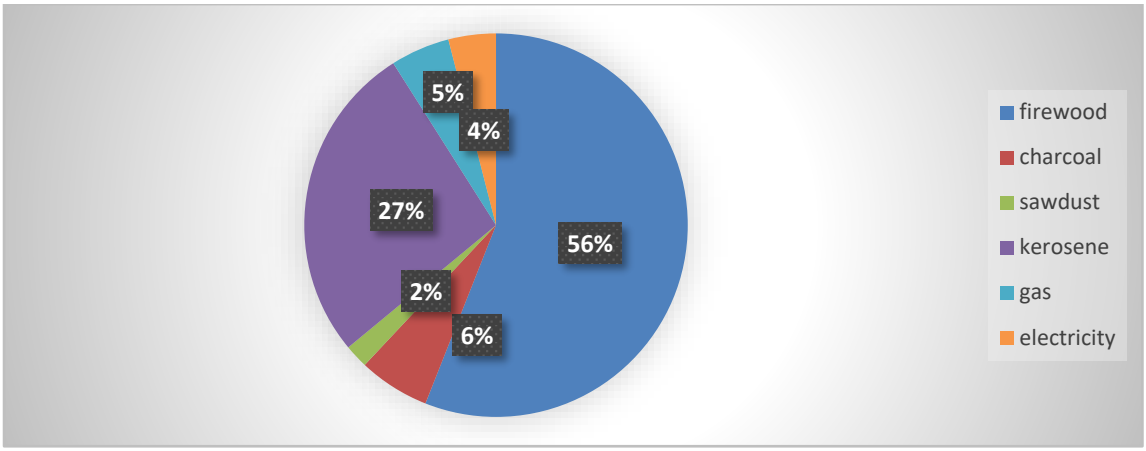

Figure 4: Nigerian Household energy mix
Source: (Ahmed, 2015)

RESULT

Based on the survey carried out, an average household in Sokoto city comprises 7 occupants which corresponds with the earlier findings in the work of (Olaniyan, Benjamin, Ogata, & Tezuka, 2018). Based on this estimate, a household of this size will require at least a two-bedroom flat with the following appliances.

Table 1: Electrical energy consumption for an average household in Sokoto under the two scenarios

Appliance	**Rating in Watt**	**Hours of operation**	
		BaU Scenario	Ideal Scenario
Lamp x 8	25	4	8
Fan x 4	85	6	10
Television	200	3	8
Cooker (cooking and heating)	1200	0	1
Desktop computer	150	4	8
Iron	1100	0.5	1

Using the end-use method, daily consumption can be calculated using the formula

$$E = \sum_{i}^{n} [Ri * Qi * Hi] /1000$$

E is the daily energy consumption in kWh, R is the rating of the appliance, Q is the quantity of the appliance and H is hours of operation of the appliance.

BaU

E = 4.59**kWh** daily, therefore monthly consumption will be 4.95*30 = 137.7**kWh** assuming a 30-day month. According to (NERC, 2020) the tariff for R2S (majority of the respondents fall

into this category) is ₦26.37/**kWh**. The total monthly expenditure on electricity will be 26.37*137.7 = ₦3, 631.149

Ideal Scenario

E = 10.1**kWh** daily, therefore monthly consumption will be 10.1*30 = 303**kWh** assuming a 30-day month. Assuming the tariff to be ₦26.37/**kWh** the total monthly expenditure on electricity will be 26.37*303 = ₦7, 990.11

To compare this with world bank threshold of **3.8%** for low income households, the respondents were grouped into three classes – Low-income (**₦30,000.00**), Middle income (**₦50,000.00**) and High-income households (**₦77,250**). The monthly expenditure recorded under BaU (**₦3,855.60**) and Ideal (**₦8,484.00**) scenarios are all higher than 3.8% for both low-income and middle-income households which are **₦1,140** and **₦1,900** respectively. In fact, the calculated values are high even for high-income households (**₦2,935.50**).

Table 2: Proportion of income spent on Electricity for various income classes under the two scenarios

Income class	**Proportion on Income spent on Electricity (%)**	
	BaU	Ideal
Low	12.10	26.63
Middle	7.26	15.98
High	4.70	10.34

Table 2 shows the proportion of household income spent on electricity for all the income classes under the two scenarios. For all income classes and under both scenarios, the proportion of income spent on electricity is higher than 3.8%. The lowest proportion of income spent on electricity for low income households is 12.85% which more than tripled the threshold value.

Table 3 shows that 79.1% of the population use fuelwood (charcoal and firewood) for cooking in Sokoto city in 2019 compared to 95% percent in 2010 (prior to the gas policies of 2015 and 2017). This is largely due to improvement in the supply and reduction in cost of gas and that people are becoming familiar with gas that they start to see it less of a danger. As a result, there is also a significant improvement in the usage of gas for cooking in the city (from 0.2% in 2010 to 5% in 2013) to17.5% in 2019 and this percentage is rapidly increasing as more gas outlets are being set up within the city.

Table 3: Percentage usage of the various cooking energy sources

Cooking Energy Source		**Percent**	**Cumulative Percent**
	firewood	48.3	48.3
	charcoal	30.8	79.1
	kerosene	3.3	82.5
	Gas	17.5	100.0

Source: Author's survey (2019)

None of the respondents said they use electricity for cooking. This can be attributed largely to the time frame in which this survey was carried out (*July-October 2019*), most of the areas under study experienced a maximum of 4 hours of supply per day within that period.

It can be seen from the chart in Figure 5 that, those that avoided electricity because of unavailability (29.2%) almost cancelled out those that avoided electricity due to affordability (32.5%). This shows that even though Nigerian tariff is among the 25 cheapest in the world, it is still costly relative to income of significant part of the population. 38.3% of the respondents avoided electricity due to safety and other reasons.

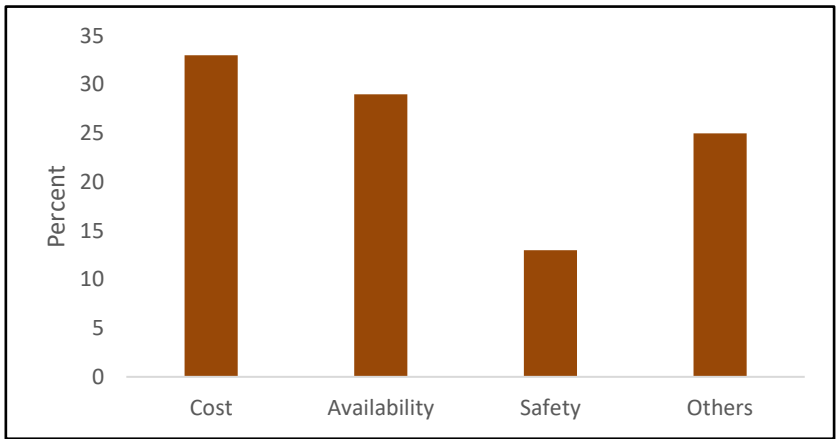

Figure 5: Reason for avoiding Electricity for cooking

The 29.2% that avoided electricity because of availability indicates that many people are able and willing to use electricity for cooking if it was to be made more available.

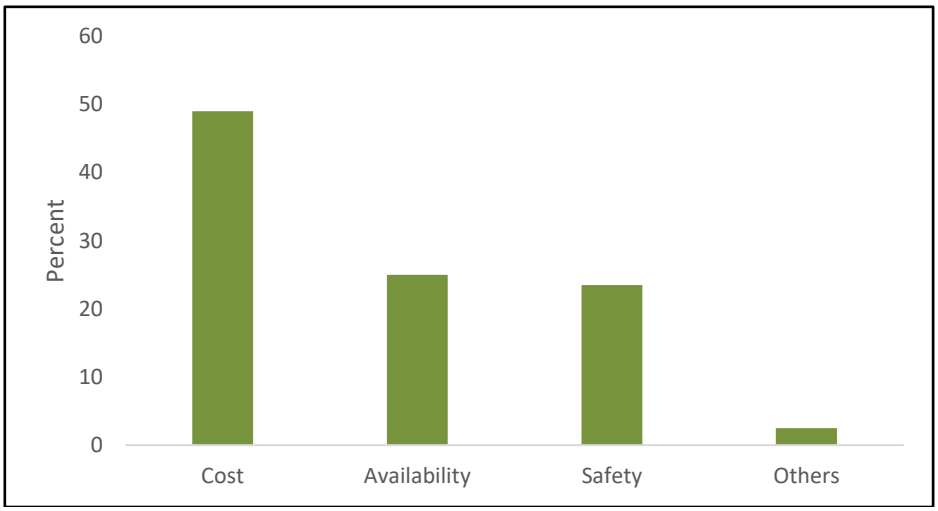

Figure 6. Reason for avoiding gas for cooking

Almost half (48.3%) of the respondents avoided gas based on unavailability and safety. This shows that by just creating awareness and improving the supply of gas more than half of the

population will choose gas as the main energy source for cooking. Another 48.3% avoided gas based on cost. Majority of those are people that do not have a gas cylinder already, so if they were to use gas, they would have to buy a cylinder first and then pay for the refill which is clearly less economical for a short-term planner. But for someone that already owns a cylinder it is even cheaper in some parts of the city to use gas than to use firewood.

The main reason people go for their energy source of choice happened to be availability and not cost as indicated in figure 3. While 55.8% of the respondents chose their energy source based on availability, only 25.8% chose the energy source based on cost. 16.7% made their choice of energy source based on safety and environmental concerns. This is further indication that even with the current price of gas and electricity more than half of the population will go for them if they were to be made more available.

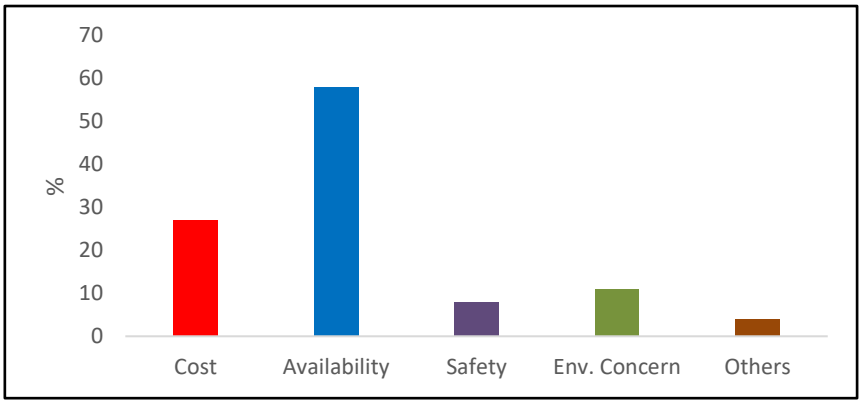

Figure 7: Reason for choice of Energy Source

CONCLUSION

In this study the efficacy of changing policies in power pricing and the federal government's intervention in natural gas supply were examined.

Lack of access is a shallow definition of Energy Poverty in Sokoto city, which is common definition mostly adopted for developing countries and by most researchers in Nigeria. The degree of affordability and accessibility to modern energy services in Sokoto city balanced out each other, so the term "Energy Poverty" in Sokoto implies lack of access due to unavailability and unaffordability. In other words, energy is unavailable as it is unaffordable.

There is improvement in residential use of LPG for cooking in Sokoto city, and more improvement may be seen in a couple of years and at a faster rate than before. The gas policy of 2017 is working in Sokoto metropolis, though at a slower pace than was expected. The policy is achieving its residential target for the use of LPG, which is a very small portion of the domestic use of gas (residential + industrial/electricity). Significant work needs to be done for this policy to achieve its target in the industrial sector.

Income poverty and Energy poverty are two different things but still related as highlighted previously by other researchers. In the context of Sokoto metropolis, almost all income poor households tend to be energy poor (which is a general case in most developing countries), and almost 50% of the energy poor households are not income poor (as highlighted in section 3).

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Assessment of the Determinants of Risk Management Capabilities and Commitments in Public Private Partnerships Projects

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Abstract:

*Risk allocation in PPP is claimed to be capability driven. This is because the party possessing the best capability of management with respect to a particular risk has the best opportunity to reduce the likelihood and control of the consequences of the risk if it materializes. Also, it has been stressed that risk management commitment is an important factor to consider when allocating risk in PPP. The research is aimed at assessing the determinants of risk management capabilities and commitments of PPP. This was achieved by identifying the project determinants of risk management capabilities and commitments of construction organizations and assessing the level of importance of those determinants for a successful risk allocation. The research adopted a quantitative approach with questionnaires distributed in Abuja, Nigeria. Mean was used for assessing the capability and commitment determinants. The research found that eleven (11) RM capability determinants and three (3) RM commitment determinants which were assessed for all the five (5) risk allocation strategies and the most important of them were sorted out. The research recommends that careful implementation of the findings of this research will improve successful achievement of PPP projects in Nigeria, and that level of influence of organisational risk management capability and commitment against risk allocation strategy could also be checked as this research has identified the various capability and commitment determinant*s.

Keywords: Risk, PPP, capabilities, commitment, determinants.

INTRODUCTION

Public Private Partnership (PPP) has been defined by the National Council for Public-Private Partnerships, USA (2009) as: "a contractual agreement between public agencies and a private entity through which the skills and assets of each sector are shared in delivering a service or facility for the use of the general public". PPP deals have been widely adopted as the approach of taking care of public services by most nations (Jin and Doloi, 2008). Resulting from high rate of social and economic boost in majority of nations, there is a great necessity for venturing into investment (World Bank, 2008). The traditional methods of providing structures by governments have resulted to ineffectuality and has made infrastructure dependent on governments having the means.

Risk management has to do with the procedure of carrying out planning, identifying, analysing, responding, and monitoring and controlling risks on a project. This is done in order to achieve a project that is risk-free. Although it is impossible to have a project that is free of risks, risk management helps reduce the negative impact of risks on a project to the barest minimum.

In order to succeed, organisations need to show commitment when addressing risk management. A conscious choice must be made at all levels of the organisation to actively identify and pursue effective risk management during the life of the project. Risk exists the moment a project is conceived. Moving forward on a project without a proactive focus on risk management increases the impact that a realised risk can have on the project and can potentially lead to project failure.

PPPs are adopted in situations of principal-agent and as a result, agency issues have been acknowledged (Mu et al., 2010; Wang and Liu, 2015). The complex nature of how the PPP projects are arranged and their unfinished contract character have resulted inamplified risk coverage for the entire parties (Marques and Berg, 2011). Aninsight that privatisation has to do with transfer of the associated risks to the private sector is still predominant in most countries (Faulkner, 2004; Papajohn et al., 2011). The method of allocating risks in PPP projects is has been claimed to be capability driven (Doloi, 2008). This being a result of Thomas et al., (2003) concluding parties with a high management capability with regards to a particular risk have ability to keep the negative consequences of the risks at their lowest. It has also been stressed that to attain optimal risk allocation, risks are to be borne by parties presenting willingness and commitment in addition to them being appropriately capable of managing the risks (Abednego and Ogunlana, 2006; Jin, 2010; Loosemore *et al*., 2006). This study therefore seeks to look at the determinants of risk management capabilities and commitments of PPP projects.

The aim of this study is to assess the determinants of risk management capabilities and commitments of PPP projects. This is important because the findings in this study will help in knowing key capability and commitment determinants in PPP by: (i) identifying the determinants of risk management capabilities in PPP projects. (ii) Identifying determinants of commitments. (iii) Assessment of the identified determinants.

LITERATURE REVIEW

Risk Management Capabilities

The abilities of parties to a project manage risk depends on their RM capabilities with respect to risk allocation, and thus it is of great importance. To achieve this, a review on organisational capability is necessary. The concept of capabilities dates back to a research by Penrose (1959).

RM capability can be further subdivided into RM routine and RM mechanism.

RM routine

According to Nonaka and Takeuchi (1995), organisations acquire capabilities through experience by recurrently carrying out related activities. In the course of carrying out these activities variances occur, leading to heterogeneous capabilities. As such organisations could be defined as entities which have heterogeneous capabilities as a function of their routines and search processes (Nelson and Winter, 1982).

RM mechanism

Capabilities tend to evolve over time to reflect the joint effects of passive learning-by-doing and deliberate firm level investments in learning and making improvements (Ethiraj *et al*., 2005). Kale *et al*., (2002) proffered that the capabilities are more likely to develop effectively when purposefully designed mechanisms are established to accumulate, store, integrate and diffuse relevant organisational knowledge acquired through experience. These mechanisms act as an important focus of firm learning (Teece and Pisano, 1994).

Thus, while greater RM experience may be a necessary condition for organisations to build RM capability, it may not be sufficient. Another factor of RM capability is the organisation's ability to effectively capture, share and disseminate the RM know-how.

Table 1: Risk Management Capabilities

S/No	Risk Management Capabilities
A	Risk management routine
1	Partner's experience in managing risk
2	Partner's understanding of consequences of project risk
3	Partner's best able to manage risk at least cost
4	Partner's heterogeneous capabilities
B	Risk management mechanism
1	Maturity of partner's risk identification and classification
2	Risk analysis mechanism of partner's
3	Risk response planning of partners
4	Risk monitoring and control mechanism of partner's
5	Partners ability to bear risk when its eventuate
6	Partner's ability to capture, share and disseminate the RM know-how
C	Partner's cooperation history
1	Partner's transaction frequency

Doloi, (2008) & Chan, (2015) identified the organisation risk management capabilities which are shown in the Table 1:

Risk Management Commitment

Capabilities in risk management remain the major concern when considering optimal risk allocation strategies, however it has been recently argued that, in order to achieve optimal risk allocation, in addition to possessing appropriate capability in risk management, a party should a risk should be borne by the party who presents willingness or commitment (Abednego and Ogunlana, 2006; Jin, 2010; Loosemore et al., 2006).

According to Johnson *et al*., (2002), commitment is therefore closely linked to effective strategy implementation such as efficient risk management (Jin and Doloi, 2008). Organisational commitment may be placed within the scope of exchange theory (Etzioni, 1961; Gould, 1979; March and Simon, 1958; Mowday *et al*., 1979). It is defined as "the belief in and acceptance of organizational goals and values, a willingness to exert effort on behalf of the organization, and a desire to maintain organizational membership" (Johnson et al., 2002, Mowday *et al*., 1982).

Ensuing Anderson and Weitz (1992), Dwyer *et al.*, (1987), and Holm *et al*., (1999), commitment could be defined as the willingness of partners to make short-term sacrifices to realize long-term benefits in the relationship. This kind of commitment is beyond "calculative" commitment, which is based solely on self-interest. In contrast, it suggests a level of "affective attachment" based not only on self-interest, but on the norm of reciprocity and on mutual attraction (Eisenberger *et al*., 1990; Gouldner, 1960). In creating a PPP, government agency and private consortium from their combined resources, contribute a set of incentives and design processes aimed at motivating the project management team to commit itself to accepting the goals and values jointly established for the project.

Most research on commitment have focused on individual commitment to managing risk, however the focus in this study is on the team commitment to risk management. It was expected that the commitment of individual will vary, at times quite dramatically (Johnson *et al.*, 2002).

Differences in individual's prior experience, national origin, involvement in decision-making, and length of tenure in the team are all likely to impact their individual level of commitment to risk management implementation. Due to the fact that members of a risk management team function as a group, their commitment as a team is important, apart from individual variations in commitment (Johnson *et al*., 2002). Although it is not assumed that all individuals have the same level of commitment, it is assumed that team members will have an overall sense of the commitment team's goals of risk management decision (Guzzo and Shea, 1990).

Ward *et al*. (1991) suggested considering the willingness of a contracting party to bear risk when allocating a given type of risk. This willingness is similar to commitment and can be measured mainly by items shown in Table 2:

Table 2: Measure of Willingness

S/No	Risk Management Capabilities
1.	General attitude to the risk.
2.	The perception of one's own ability to manage the risk.
3.	The perceived reward for bearing the risk.

RESEARCH METHODOLOGY

The research adopted a quantitative approach. Data was collected using close ended questionnaires from construction firms. A total of 68 questionnaires were distributed to construction firms in Abuja. The target population of the survey were building contractors, consultants and decision makers who have been or likely to be involved in risk management of PPP projects in Nigeria and precisely in Abuja because that is the heart of construction companies in Nigeria. The respondent were selective randomly using purposive sampling. The Abuja galleria website (www.abjbusinessdirectory.com) was used to acquire details of construction companies in Abuja.

The data collected was analysed using descriptive statistics tools. The Statistical Package for Social Science (SPSS) software was used for the analysis. Mean was used for assessing the capability and commitment determinants.

RESULTS AND DISCUSSION

Assessment of risk management capabilities and commitments for risk allocation

Retain all the Risk

The **Table 3** shows the assessment of RM capability and commitment determinants for "Retain all" risk allocation strategy. It indicates the level of importance of each determinant in selecting the risk allocation strategy "Retain all the risk", with their mean scores which were gotten using a Likert scale of 1-5, where 1 denotes not important and 5 denotes very important. The table indicated from the aspect of RM capabilities that the 3 most important determinant are A1="Partners experience in managing the risk", A2= "Partners understanding of consequences of project risk" and A10= "Partners ability to capture, share and disseminate the RM know-how". They are the determinant with the highest mean values.

In summary, the Table shows the 3 most important RM capability determinants to be considered with respect to the risk allocation strategy are;

i. A1= Partners experience in managing the risk
ii. A2= Partners understanding of consequences of project risk
iii. A10= Partners ability to capture, share and disseminate the RM know-how

The Table also shows form the aspect of RM commitment the mean values of the determinant and indicated the most important commitment determinant for every risk allocation strategy.

Table 3: Risk Management Capabilities and Commitments for "Retain all"

	Determinants	Mean	STD	Rank
	Capabilities Determinants			
A1	Partners experience in managing risk	4.06	0.98	1
A2	Partners understanding of consequences of project risk	4.03	0.95	2
A10	partners ability to capture, share and disseminate the RM know-how	3.94	0.97	3
A7	risk response planning of partners	3.91	1.16	4
A3	Partners best able to manage risk at least cost	3.88	1.14	5
A6	Risk analysis mechanism of partners	3.85	1.12	6
A5	Maturity of partners risk identification and classification	3.85	1.03	6
A8	Risk monitoring and control mechanism of partners	3.73	1.13	7
A9	Partners ability to bear risk when its eventuate	3.67	1.24	8
A4	Partners heterogeneous capabilities	3.61	0.89	9
A11	Partners transaction frequency	3.45	1.25	10
	Commitment Determinants			
B2	Perception of one's own ability to manage the risk	3.97	0.98	1
B3	Perceived reward for bearing the risk	3.70	1.29	2
B1	Attitude to the risk	3.58	1.28	3

Transfer a Small Portion of the Risk

As shown in the table below (**Table 4)** the 3 most important determinants with the highest mean values are A3= "Partners best able to manage risk at least cost", A9= "Partners ability to bear risk when its eventuate" and A4= "Partners heterogeneous capabilities" this signifies that these are the most important RM capability determinant to be considered in the risk allocation "Transfer a small portion of the risk". They are the determinants for this risk allocation strategy that were mapped with all the RM commitment determinants.

In summary they are;

a) A3= "Partners best able to manage risk at least cost"
b) A4= "Partners heterogeneous capabilities"
c) A9= "Partners ability to bear risk when it eventuate"

Equally Share the Risk

Table **5** shows that the 3 most important RM capability determinants to be considered are A5= "Maturity of partners risk identification and classification", A1= "Partners experience in managing risk" and A2= "Partners understanding of consequences of project risk" as they emerged the first 3 in the rankings with the highest mean values. So in the risk allocation strategy "Equally share the risk" the above RM capability determinants are to be considered first. They are the determinants that were mapped with all the RM commitment determinants.

In summary they;

A1= "Partners experience in managing risk"

A2= "Partners understanding of consequences of project risk"

A5= "Maturity of partners risk identification and classification"

Table 4: Risk Management Capabilities and Commitments for "Transfer a Small Portion"

	Determinants	Mean	STD	Rank
	Capabilities Determinants			
A3	Partners best able to manage risk at least cost	3.67	1.11	1
A9	Partners ability to bear risk when its eventuate	3.58	1.00	2
A1	Partners experience in managing risk	3.52	1.03	3
A4	Partners heterogeneous capabilities	3.52	0.97	3
A5	Maturity of partners risk identification and classification	3.45	1.09	4
A6	Risk analysis mechanism of partners	3.39	1.17	5
A7	risk response planning of partners	3.33	1.19	6
A8	Risk monitoring and control mechanism of partners	3.36	1.19	6
A10	partners ability to capture, share and disseminate the RM know-how	3.33	1.22	6
A8	Risk monitoring and control mechanism of partners	3.36	1.19	7
A11	Partners transaction frequency	3.24	1.00	8
	Commitment Determinants			
B2	Perception of one's own ability to manage the risk	3.55	1.03	1
B3	Perceived reward for bearing the risk	3.48	1.18	2
B1	Attitude to the risk	3.39	1.03	3

Table 5:Risk Management Capabilities and Commitments for "Equally Share"

	Determinants	Mean	STD	Rank
	Capabilities Determinants			
A5	Maturity of partners risk identification and classification	3.91	0.81	1
A3	Partners best able to manage risk at least cost	3.79	0.96	2
A1	Partners experience in managing risk	3.79	0.96	2
A2	Partners understanding of consequences of project risk	3.67	0.82	3
A6	Risk analysis mechanism of partners	3.64	0.89	4
A6	Risk analysis mechanism of partners	3.64	0.89	4
A7	risk response planning of partners	3.58	0.90	5
A4	Partners heterogeneous capabilities	3.58	0.83	5
A7	risk response planning of partners	3.58	0.90	5
A10	partners ability to capture, share and disseminate the RM know-how	3.48	0.87	6
A9	Partners ability to bear risk when its eventuate	3.42	0.90	7
	Commitment Determinants			
B1	Attitude to the risk	4.00	0.71	1
B3	Perceived reward for bearing the risk	3.55	0.97	2
B2	Perception of one's own ability to manage the risk	3.48	1.00	3

Retain a Small Portion of the Risk

From the below table (**Table 6)**, it is concluded that the 3 most important RM capability determinants in regards to the risk allocation "Retain a small portion of the risk" are A1= "Partners experience in managing risk", A4= "Partners heterogeneous capabilities" and also A6= "Risk analysis mechanism of partners". So in the risk allocation strategy "Retain a small portion of the risk" the most important RM capability determinants to consider are the above listed determinants. They are also the determinants that were mapped with all the RM commitment determinants.

In summary they are;

1. A1= "Partners experience in managing risk"
2. A4= "Partners heterogeneous capabilities"
3. A6= "Risk analysis mechanism of partners"

Table 6: Risk Management Capabilities and Commitments for "Retain a Small Portion"

	Determinants	Mean	STD	Rank
	Capabilities Determinants			
A1	Partners experience in managing risk	3.42	1.15	1
A6	Risk analysis mechanism of partners	3.36	0.78	2
A4	Partners heterogeneous capabilities	3.36	0.89	2
A3	Partners best able to manage risk at least cost	3.27	1.01	3
A5	Maturity of partners risk identification and classification	3.24	1.23	4
A9	Partners ability to bear risk when its eventuate	3.21	1.02	5
A7	risk response planning of partners	3.06	0.93	6
A10	partners ability to capture, share and disseminate the RM know-how	2.94	1.06	7
A11	Partners transaction frequency	2.94	1.14	7
A2	Partners understanding of consequences of project risk	2.88	0.82	8
A8	Risk monitoring and control mechanism of partners	2.91	0.91	8
B3	Perceived reward for bearing the risk	3.18	1.25	1
B1	Attitude to the risk	3.15	1.20	2
B2	Perception of one's own ability to manage the risk	3.00	1.22	3

Transfer all the Risk

Table 7 which is for RM capabilities and commitments against the risk allocation strategy "Transfer all the risk" which is the last risk allocation strategy, it shows that the 3 most important RM capability determinants to be consider in respect of the above risk allocation strategy are A4= "Partners heterogeneous capabilities", A3= "Partners best able to manage risk at least cost" and also A6= "Risk analysis mechanism of partners". They are also the determinants that were mapped with all the RM commitment determinants.

In summary they are;

1. A3= "Partners best able to manage risk at least cost"
2. A4= "Partners heterogeneous capabilities"
3. A6= "Risk analysis mechanism of partners"

Table 7: Risk Management Capabilities and Commitments for "Transfer all"

	Determinants	Mean	STD	Rank
	Capabilities Determinants			
A4	Partners heterogeneous capabilities	3.79	1.34	1
A3	Partners best able to manage risk at least cost	3.58	1.17	2
A6	Risk analysis mechanism of partners	3.52	1.20	3
A5	Maturity of partners risk identification and classification	3.48	1.34	4
A2	Partners understanding of consequences of project risk	3.42	1.15	5
A7	risk response planning of partners	3.39	1.19	6
A9	Partners ability to bear risk when its eventuate	3.36	1.17	7
A1	Partners experience in managing risk	3.27	1.21	8
A10	partners ability to capture, share and disseminate the RM know-how	3.21	1.32	9
A8	Risk monitoring and control mechanism of partners	3.15	1.15	10
A11	Partners transaction frequency	3.12	1.29	11
	Commitment Determinants			
B2	Perception of one's own ability to manage the risk	3.45	1.33	1
B3	Perceived reward for bearing the risk	3.21	1.32	2
B1	Attitude to the risk	3.00	1.48	3

CONCLUSIONS AND RECOMMENDATIONS

The research using literature found out the various RM capability and commitment determinants which were assessed for five (5) risk allocation strategies and the most important of them taken into consideration. The research also found out that the RM commitment determinants used are all important via literature. So the most important of the RM capability determinant for the various risk allocation strategy are:

1. Partners experience in managing the risk, Partners understanding of consequences of project risk, Partners ability to capture, share and disseminate the RM know-how, are the most important capability determinants for the risk allocation strategy "Retain all the risk".
2. Partners best able to manage risk at least cost, Partners heterogeneous capabilities, Partners ability to bear risk when it's eventuate, are for "Transfer a small portion of the risk".
3. Partners experience in managing risk, Partners understanding of consequences of project risk, Maturity of partners risk identification and classification, are for "Equally share the risk".
4. Partners experience in managing risk, Partners heterogeneous capabilities, Risk analysis mechanism of partners, are for "Retain a small portion of the risk".
5. Partners best able to manage risk at least cost**,** Partners heterogeneous capabilities**,** Risk analysis mechanism of partners, are the most important risk management determinant for allocation strategy "Transfer all the risk".

Based on the result obtained from this study, the following are recommended as ways of improving successful achievement of PPP project:

1. Careful implementation of the findings of this research will improve successful achievement of PPP projects in Nigeria.
2. Level of influence of organisational risk management capability and commitment against risk allocation strategy should also be checked as this research has identified the various capability and commitment determinants.

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Conceptual Framework for an Effective Management of Public-Private Partnership Infrastructure Project Stakeholders to Minimise Project Failure in North Central, Nigeria

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Abstract:

Public- Private Partnership (PPP) brings together the Private sector managerial expertise and Public sector regulatory and supervisory capacity in the provision of public infrastructure projects. Several problems have been encountered on PPP initiatives in Nigeria, especially in the North Central region where many PPP infrastructure projects have experienced challenges and failures as a result of stakeholder's opposition and disagreements arising from the neglect of stakeholders' interest. Previous research have developed frameworks and models for managing project stakeholders in conventional procurement system which is unsuitable for managing the challenges of stakeholders in PPP infrastructure projects. As such, identification and management of stakeholders in PPPs is crucial to the success of PPP projects. Hence, there is need to develop a conceptual framework upon which an effective strategy to minimise PPP infrastructure projects failure through effective stakeholders management amidst well designed institutional and regulatory framework and a conducive investment climate. This research intends to bridge the gap in the literature by providing an operational strategy to minimise failure of PPP infrastructure projects through effective management of PPP project stakeholders in North Central region of Nigeria. This strategy could be applied to minimise PPP infrastructure failure in developing countries.

Keywords: *Conceptual Framework, Failure, Nigeria, Public-Private Partnership Infrastructure projects, Stakeholders.*

INTRODUCTION

Public-Private Partnerships have become a popular institutional arrangement and many public infrastructure projects such as Roads, rail, airports, hospitals, housing, and schools among others have been procured through PPP, yet many PPP infrastructure projects have experience some challenges that lead to undesirable outcomes such as delays, litigations, terminations, revocation of concessions and failures as a result of stakeholder's opposition and resistance (Amadi *et al.,* 2014; Babatunde, 2015). This is corroborated by El-Gohary *et al.* (2006) that stakeholder's conflicts are the main causes of PPP project failures. However, end users and other stakeholder's resistance in PPP occur where charges are expected to be collected directly from the users on the use of public infrastructures such as; Roads, water facilities, electricity among others (World Economic Forum 2010; El-Gohary *et al.*, 2006).

Stakeholders are groups, individuals or organisation that are either affected by or affect the implementation of PPP infrastructure projects. (Freeman, *et al.*, 2010). PPP stakeholders includes; political bodies, government authorities (MDAs), consultants, private investors/concessionaires, contractors, sub-contractors/suppliers, financial institutions, operation and maintenance organisations, users and community at large. For PPP project to be successful, it is important to involve and manage all PPP stakeholders from the initiation stage to the completion stage of the project (El-Gohary *et al.*, 2006). Stakeholder management has the capacity to provide strategic information, resources and problem-solving techniques and also offer all stakeholders the opportunity to contribute meaningfully towards the success of the PPP projects (Foo *et al.*, 2011; Amadi *et al.,* 2014).

PPPs which is globally perceived as a medium for infrastructure deficit reduction, has become controversial in Nigeria as a result of stakeholders' opposition and resistance. Thus, causing diminishing interest for both the local and foreign private investors (Amadi *et al.,* 2014; Babatunde *et al*., 2015). Despite the adoption of PPP in Nigeria, there are still challenges that are hampering the development of infrastructure under PPPs, especially in the North Central region of Nigeria. Though, several frameworks and models have been developed for managing project stakeholders in conventional procurement system, nevertheless, there is no known framework developed for managing the challenges of stakeholders in PPP infrastructure projects in Nigeria. As such, this paper proposes the development of a conceptual framework for stakeholder's management in PPP infrastructure projects with a view to minimising failure of PPP projects, with specific focus on the North Central region of Nigeria.

PUBLIC- PRIVATE PARTNERSHIP INFRASTRUCTURE PROJECTS DEVELOPMENT IN NIGERIA

The involvement of the private sector in the development and financing of public infrastructure has increased substantially over the past decade (Li *et al.*, 2005). The concept of PPP is now regarded as a veritable tool in the procurement of public facilities and services in Nigeria. PPP is a generic term for the different forms of relationship existing between the public sector and the private sector with the aim of financing, developing, building/constructing and for the effective management of public infrastructure (UNECE 2008; Robinson *et al.,* 2010; Amadi *et al.,* 2014). These relationships are usually long term where the concession arrangement could last up to 35 years to enable the private sector repay loans sourced from the financial institutions (Smyth and Edkins, 2007). There are different types of PPPs that are often implemented. These PPP models differs in terms of both the public and private sector involvement such as: Build-Operate-Transfer (BOT); Build-Own-Operate-Transfer (BOOT); Build-Own-Operate (BOO); Design- Build-Operate-Transfer (DBOT); Design-Build-Finance-Operation (DBFO) among others. PPP has been adopted in the procurement of projects in Nigeria. These projects ssincludes: the concession of Lagos-Ibadan expressway and the new terminal at the Murtala Mohammed Airport both handled by Bi-Courtney Limited, the concession of the first phase of Epe-Lekki toll road in lagos, 105KM Lagos-Ibadan Road, Housing estate development in states including Niger, Adamawa, Ogun, Ondo, Bauchi, Lagos, Federal Capital Territory among others.

PPP Infrastructure Projects Development in North Central, Nigeria

PPP has been adopted in the provision of public infrastructure projects in Nigeria particularly the North Central region of Nigeria. These Projects includes; the concession of Nnamdi Azikiwe International Airport Abuja, concession for complete infrastructure provision at Katempe, Abuja, the concession for the provision of Minna City housing project in Maikunkele, Construction of Minna Five Star Hotel, The Concession of Benue Cargo airport which was awarded to Aerotropolis Development Company Ltd, construction of Jos Main Market and the provision of Hospital facilities in Jos East, construction of road networks in FCT as the Federal Government pursues the implementation of the Abuja Master plan, Development of 1MW Hydropower Doma Dam in Nasarawa State, among others (Adeogun and Taiwo, 2011; Ibem and Aduwo, 2012; ICRC 2012; Taiwo, 2013; Mudi *et al*., 2015; Ojo, 2017). Despite the increasing adoption of PPPs, in Nigeria including the North Central zone of

Nigeria, the experiences of stakeholders, principally the local and foreign investors have not always been positive due to controversies, failures, delays, and revocation of concessions (Babatunde *et al*., 2015; Mudi *et al*., 2015).

The Stakeholders Theory

The word 'stakeholder' originated from Stanford Research Institute (SRI) in the 1960s

(Freeman 1984). Freeman *et al*. (2010) assert that the main idea underlying the stakeholder theory is that the organisations are committed to addressing a set of stakeholders' expectations. Babatunde (2015) further identified the main proponents of stakeholder's theory as follows: the interests of all stakeholders have intrinsic value, and no set of interests are assumed to dominate the others; the theory focuses on management decision-making; and the organisation has relationships with many groups (stakeholders) that affect and are affected by its decisions. Also, Yang *et al.* (2011) identified three-way categorisation of approaches to the stakeholder theory. This includes normative stakeholder theory; descriptive stakeholder theory; and instrumental stakeholder theory. Friedman and Miles (2006) state that normative stakeholder theory encompasses theories of how stakeholders should act and view the purpose of the organisation, based on some ethical principle. Descriptive stakeholder theory is concerned with how stakeholders behave and how they view their actions and roles. Lastly, instrumental stakeholder theory deals with how stakeholders should act if they want to favour and work for their interests (Fontaine *et al*., 2006; Friedman and Miles, 2006; Babatunde, 2015). The advantage that the stakeholder theory offers to PPPs is its normative approach towards stakeholder inclusion focusing on their behavioural patterns and relationship management for project success (Aladpoosh *et al*., 2012; Bakhtawar *et al.*, 2018).

Theoretical framework for managing stakeholders in construction projects

In figure 1. Yang *et al.* (2010) developed a framework for managing stakeholders in conventional projects where they identified "managing stakeholders with social responsibilities (economic, legal, environmental and ethical)" as the most important critical success factors for success of stakeholder's management. This finding was in line with the studies of (Wood and Gray, 1991; Donalson and Preston, 1995). Economic responsibility according to Yang *et al.* (2010) is the obligation to produce goods and services, sell them at fair prices and make profit, legal responsibility is the obligation to obey the law; and ethical responsibility covers those issues not embodied in law but expected by society. The framework shown in figure1, is only suitable for managing stakeholders in conventional construction projects and not adequate in addressing the challenges of stakeholders in PPP infrastructure projects as a result of some apparent flows of their processes (Amadi *et al.*, 2014)

Public-Private Partnership Stakeholders

El-Gohary *et al.* (2006) grouped stakeholders into; responsible, impacted or interested. Responsible stakeholder refers to an organisation or individual who has some degree of responsibility or liability with regard to the development PPP projects, such as Public sector (MDAs), Concessionaire, Contractors, Consultants, Financial institutions; among others) as shown in figure 2. An impacted stakeholder is an organisation or individual who is directly or indirectly affected by the development process; and was classified into three main sub-domains': residents, users and owners. Impacted stakeholders are further grouped as negatively or positively impacted. Finally, an interested stakeholder is an organisation or individual that

is not directly impacted by the project, but who would like to participate and provide his opinion in the infrastructure development process. This includes various players such as social institutions, environmentalists and media representatives.

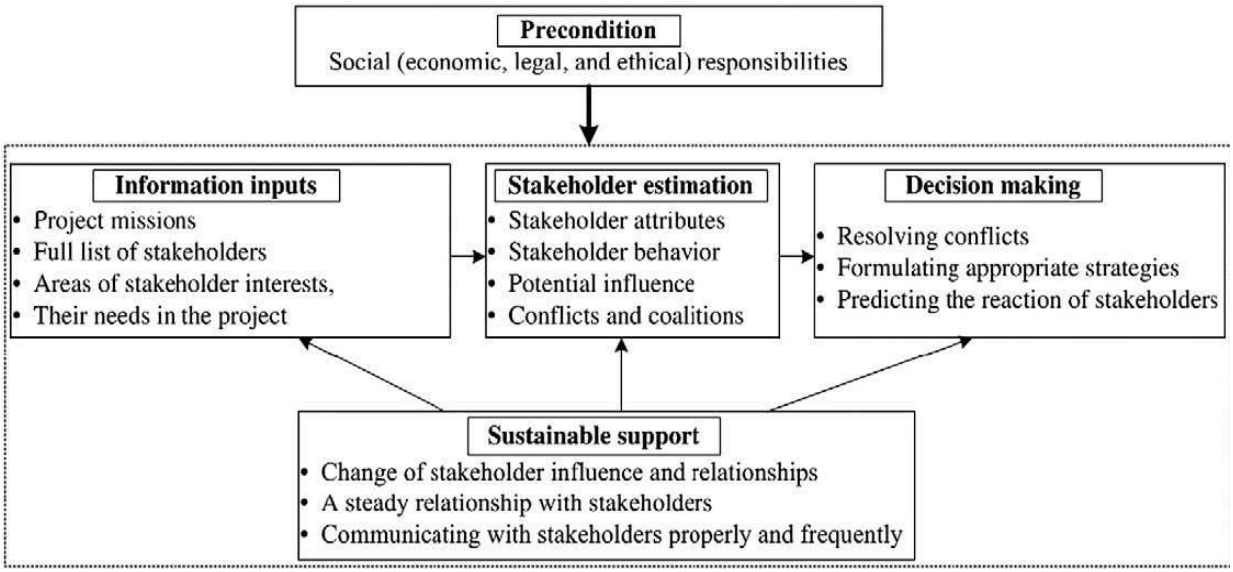

Fig. 1. A framework for successful stakeholder management in construction (Yang *et al*., 2010)

ENHANCING SUCCESS IN PPP PROJECTS: CONCEPTUALISED FRAMEWORK FOR EFFECTIVE MANAGEMNT OF PPP STAKEHOLDERS

Earlier studies on stakeholders have classified stakeholders into two groups, namely; Internal/Primary and External/Secondary stakeholders (Harris, 2010; Leung, 2010; Winch, 2010). Leung (2010) point out that, Internal stakeholders are entities with legal contract to the project such as; Government authorities, concessionaires, private investors, consultants among others while external stakeholders are entities with interest in the project but without a contract such as; users, NGOs, media and local communities. Managing stakeholders in PPP is trust based collaborations between the public and private sector towards the achievement of set of objectives (Andriof and Waddock, 2002). Stakeholder's management is a concept that describes an organisations' resolve to manage relationships with its stakeholders group in a proactive manner (Freeman, 1984; Chinyio and Olomolaiye, 2010). The essence of managing relationships is to motivate stakeholders to act in a manner that enhance the successful implementation of PPP projects (Harris, 2010; Amadi *et al*., 2014). Also, governments are responsible to establishing programs and develop the necessary capacity to ensure PPP project success. The way a government shapes the environment for PPP development will depend on the institutional context where projects take place. The policy interventions will have an impact on the institutional capabilities of the environment to foster PPP development and provide an enabling environment (Jooste *et al*., 2011, Castano *et al*., 2012). Apparently, managing PPP stakeholders amidst favourable investment climate and a well-designed institutional and regulatory framework by the government will minimise PPP projects failure thereby enhancing project success.

PPP stakeholders' management

Stakeholders in PPP infrastructure projects are more sensitive and complex that in a typical construction projects (Jayasuriya *et al*., 2016). It therefore requires proactive efforts in managing the various stakeholder's roles and responsibilities in the project (El-Gohary, 2006; Bakhtawar *et al.,* 2018). The stakeholders activities is not only important for addressing the ineffective risk allocation issues in PPP contracts but is also desirable for prevention of opposition and conflicts (Burke and Demirag, 2017). Therefore, to minimise failure in PPP projects, this research developed a conceptual framework for stakeholder's management in PPP projects (see figure.2). The framework builds on the stakeholder's theory and Yang *et al.* stakeholder's framework (Freeman and Reed 1983; Yang *et al*., 2010), taking into consideration the expectation and roles of different stakeholders. For instance; the public sector in providing a conducive investment environment and institutional and regulatory framework for the motivation of private sectors to invest in PPP infrastructure projects. In figure 2 below. The conceptual framework includes the attributes of investment climate and institutional framework for influencing the private sector participation towards the successful delivery of PPP projects. The framework also takes into consideration the role of trust and communication in enhancing the success of PPP infrastructure projects.

Stakeholder's identification in PPPs

Stakeholders management begin with the identification and collection of information about all involved stakeholders (Internal and external stakeholders) which will be utilise in the subsequent management activities. Identifying the full list of stakeholders will assist to ascertain the stakeholders in the project (Frooman, 1999). Stakeholders' information is important in assessing their involvement in the project. This information includes: stakeholders contact information, their interest, needs, commitment and constraints to project delivery (Freeman *et al.,* 2007)

Stakeholders involvement in PPP infrastructure Projects

Stakeholder's involvement in PPP infrastructure projects plays a very important role in project delivery. Stakeholder in this context refers to any person or organisation that has a legitimate interest in the implementation of PPP infrastructure project. The involvement of stakeholders in PPP projects is essential because it reduces opposition and help to mobilise necessary resources for project implementation (Klijn and Koppenjan, 2016). Involving and managing stakeholders within a PPP project reduces the opposition from societal or citizens groups. Studies have revealed that major PPP road infrastructure projects in the United State have encountered various problems which eventually led to project failure due to stakeholders' opposition (Levy, 1996; El-Gohary *et al*., 2006). Levy (1996) further state that these failures were mainly because the public was unaware of the concept of PPP, not sufficiently educated about PPP and were denied access to detailed information contained in the consortium PPP proposals. Also, the involvement of stakeholders in PPP projects provides an improvement of content and innovation (Nederhand and Klijn, 2019). When private consortia are involved, better innovation and more tailor-made solution are achieved leading to more information, knowledge, ideas, creativity and overall project success (Hodge *et al*., 2010). The engagement of groups or individuals outside the government and private sector as part of the stakeholders to be engaged in consultation at the inception stage of PPP is important to the implementation

of PPP infrastructure projects. These groups includes: Communities/ Residents/users, media, labour unions, special interest groups among others.

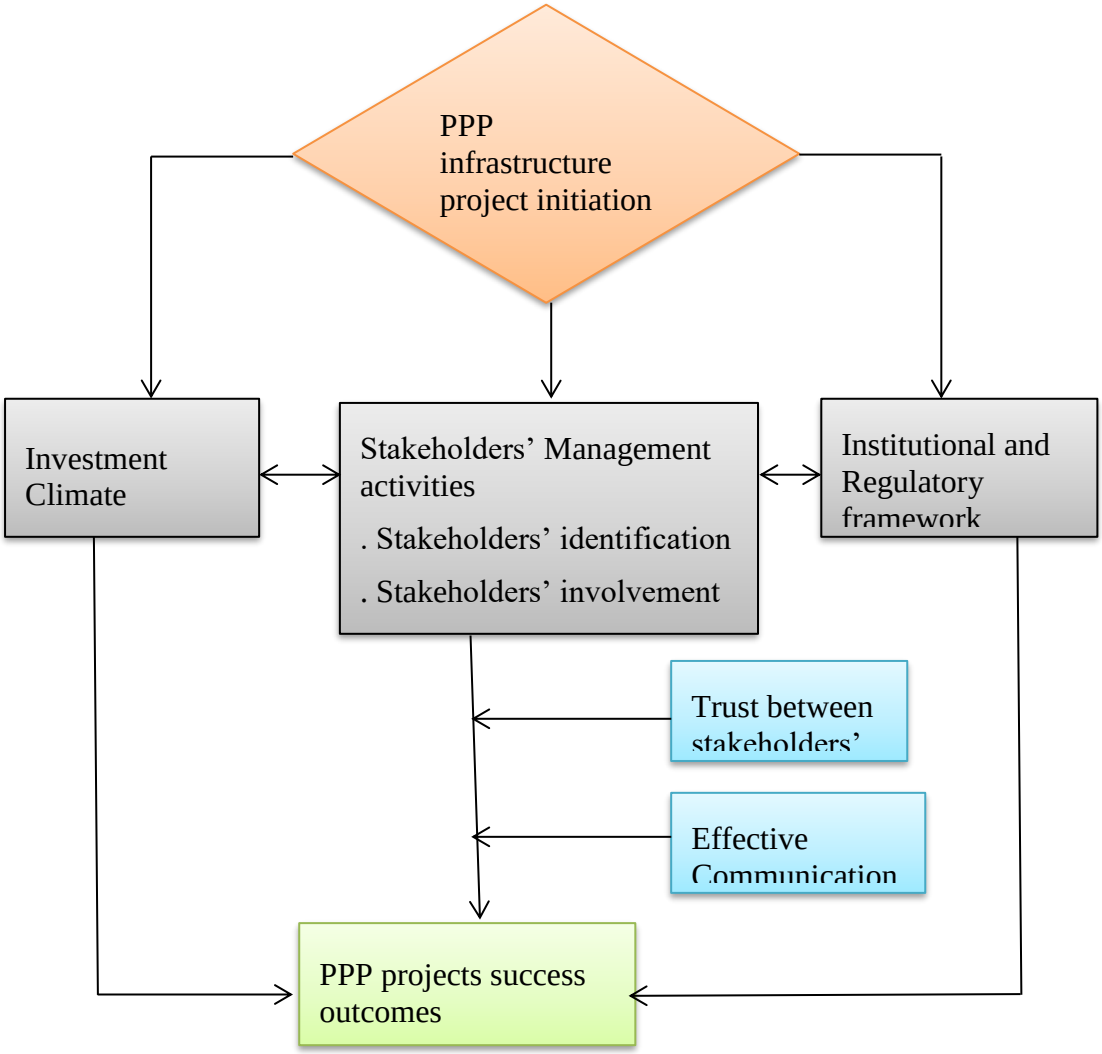

Fig.2: Conceptual Framework for Management of Stakeholders in PPP Projects

Stakeholders support in PPPs

Stakeholders' management in PPP project requires continuous support from the initiation to the completion stage. The stakeholders support activities necessary for project success includes; ***a.*** communication with and engaging stakeholders properly and frequently ***b.*** Realising changes of stakeholders' information, influences, relationship and behaviour during the project process ***c.*** Keeping and promoting an on-going relationship with stakeholders. ***d.*** Private sector obtaining support and assistance from the public sector by reducing the bottlenecks in the approval processes (Yang *et al.*, 2009).

Investment climate for Public-Private Partnership

Conducive investment climate has long been recognised as a pre-requisite for attracting investment and thus fostering economic growth. The investment climate is defined as the

institutional, policy, and regulatory environment in which firms operate (Emirullah and Azam, 2014). Key determinants of the investment climate include economic and political stability, rule of law, infrastructure, approaches to regulations and taxes, functioning of labour and finance markets, and broader features of governance (World Bank, 2005, Emirullah and Azam, 2014). Investment climate is the institutional and policy environment that influence the involvement of stakeholders such as; local and foreign investors in PPP infrastructure projects. Investment climate is crucial because the private sector would not be interested to participate in a PPP arrangement if the situation in the country is not conducive. Therefore, Emirullah and Azam (2014) posited that, an enabling environment should be established so that private sectors can be compensated with reasonable returns for putting a significant amount of resources which constitute a high degree of risk due to long-term nature of PPP investment.

PPP Institutional and regulatory framework

The regulation of PPPs in the delivery of infrastructure projects can produce harmful consequences when poorly designed and implemented (World Bank, 2006). A sound institutional framework conducive to PPPs that ensures government commitment, transparency, predictability, and coherence, is a major determinant of project success and private investor engagement in PPPs (World Bank, 2011; Babatunde, 2015). The government has to do the needful in providing an enabling environment and commercially oriented framework of law and regulation to enable PPPs to flourish (UNECE, 2008). Thus, the legal framework should be well designed to accommodate all stakeholders in PPPs and to protect their rights among others (UNECE, 2008).

The role of Trust in PPP infrastructure project

Trust is a fundamental factor when building a relationship and it has shown to improve productivity (Wong and Cheung, 2004). Rousseau *et al.* (1998) describe trust as a psychological state comprising the intention to accept vulnerability based upon positive expectation of the intention or behaviour of another. Trust is an efficient way to lower transaction costs in partnership thereby enhancing the successful delivery of PPP projects (Parker and Hartley, 2003). Trust facilitates cooperation as it creates greater predictability and reduces the risk inherent in transaction and cooperative relations (Nooteboom, 2002). Trust has a positive and negative consequence on PPP project performance as lack of trust may cause project failure while the presence of trust will improve productivity and project success. Smyth and Edkim (2007) discover that, many of the critical relationships such as Special Purpose Company (SPC)-Public client relationship are negative and lack trust and confidence, resulting to failure of PPP infrastructure projects.

Effective Communication among Stakeholders in PPP project

Communication can be seen as an interactive cycle including a sender, receiver, message, media, and a possible feedback (Siering and Svensson, 2012). Communication should not be a one-way processes rather, a two-way process. Clegg et al. (2008) states that communication is an activity to create, shape, maintain relationship and endorsing mutual understanding. It is important to establish a good communication channels with all stakeholders, both internal and external by setting clear communication goals, keeping active involvement and being persistent

(Manowong and Ogunlana, 2010). This is corroborated by Bourne (2009) that, it is important to target the communication with the right information in the right way to the specific stakeholders especially the external stakeholders, who are not fully involved in the implementation process.

CONCLUSION

Stakeholder management in PPP infrastructure projects is generally about managing diverse stakes (Internal and external stakeholders). It is a crucial and an important endeavour that can yield maximum benefit to both the public and the private sector; such as improving performance of PPP projects, minimising projects failure, stimulating local and foreign investor's interest in PPP infrastructure projects among others. The study has conceptually rationalised the stakeholders' activities and other influencing attributes as steps in minimising the inherent failures of PPP infrastructure projects. Failure to manage stakeholders can impact negatively on the projects; such as early termination of concession agreements, delays, failures and controversies. The main purpose of this paper is to minimise failure of PPP infrastructure projects; as such the framework has brought together different variables that will improve stakeholder's management in PPPs thereby reducing unforeseen risks, negative actions and reactions that have potential impact upon the project success, thus, when applied will improve the success rate in the delivery of PPP infrastructure projects.

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Assessment of Factors Influencing the Various Procurement Methods in the Delivery of Commercial Building Projects in Abuja, Nigeria

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Abstract:

Selecting an appropriate project procurement method is a complex decision-making process. The decision to select the appropriate procurement method to implement a construction project is crucial as it invariably affect project performance and delivery. Procurement of infrastructure project is facing a global challenge with the case of developing nations being of unique interest. This study assesses the factors influencing procurement methods in the delivery of commercial building projects in Abuja, Nigeria. The study considered five (5) procurement methods and nineteen (19) factors relating to the Nigerian Construction industry. The study adopted the quantitative survey research approach and data were collected with the aid of a well-structured questionnaire administered to 130 respondents of which and 95 were returned. Collected data were analysed using Relative Importance Index (RII). The study revealed that out of the nineteen factors considered, four (4) were found to be very important which are Project Completion at Estimated Cost, Cash flow and Funding Arrangement, Financial Capability of Client and Expected Performance of Project with RII of 0.91, 0.90, 0.89 and 0.80 respectively. While the fifteen (15) others were of less importance with RII ranging from 0.79 (Size of Project) to 0.61(Quality Certification) and a general average RII of 0.76. This study revealed that all factors influencing the procurement methods in commercial project delivery are important, with varying levels of importance where some have higher RII than others. This indicates that these factors seem to determine the procurement method that will be employed for a commercial project.

Keywords: Construction, projects, Procurement, Factors, Delivery.

INTRODUCTION

The construction industry contributes to the socio-economic growth of any nation. Procurement methods for construction industry can be defined as the organisational structure adopted by client for the management of the design and construction of a building project (Masterman, 2002). However, procurement methods define the management, functional and contractual arrangement and relationship amongst project team. The procurement of construction projects is vast in scope as it involves the gathering and organising of myriads of separate individuals, firms and companies to design, manage and build construction products such as houses, office buildings, shopping complex, roads and bridges for specific clients. Different procurement methods are used for different construction projects and the correct choice may help to avoid problems and be the key to the attainment of project specific goals (Eyitope *et al.*, 2012). The selection of procurement system therefore becomes a very important task for clients, as employing an inappropriate procurement system may lead to project failure (Chua et al., 1999). Clients have the responsibility to select the most appropriate procurement method for their construction projects. This has become imperative because the client is faced with various options to procure his project (Okunlola, 2012). Selecting an appropriate project procurement method is a complex decision-making process due to risks and uncertainties. Moreover, it depends largely on the accurate identification of client requirements involved. At the time of decision, the clients and stakeholders often have little information and the project plans are not

detailed enough to make a judgment about the project with certainty of outcomes (Daniel, 2012).

The decision to select the appropriate procurement method to implement a construction project is crucial as it invariably affect the project performance and delivery. Procurement of infrastructure project is facing a global challenge. However, the case of developing nations is of unique interest (Ogunsanya *et al*., 2016).Therefore, this study seeks to assess the factors influencing procurement methods in the delivery of commercial building projects in Abuja, Nigeria. These factors mostly relate to time, cost and quality with other underlying important factors that affect procurement selection.

Types of Construction Project Procurement Methods

Different procurement methods are used for different construction projects and the correct choice may help to avoid problems and be the key to the attainment of project specific goals (Eyitope *et al*., 2012).The traditional design-bid-build system of procurement is still dominant in the Nigerian construction sector and this may likely continue to be the trend. However, research has shown that Nigerian construction industry adopts all procurement methods in one form or another (Idoro, 2012). Apart from the traditional approach, there are now other "fast-tracking" or innovative procurement systems used by the construction industry worldwide. The variants of procurement methods available today came about from the need to improve construction project delivery, that is, project completion within budget time and acceptable quality (Project Management Institute (PMI), 2004).. The different procurement systems differ from each other in term of allocation of responsibilities, activities sequencing, process and procedure and organizational approach in project delivery (Olugbenga *et al*., 2013). These differences have invariably affected the project performance. The different procurements method commonly in used for the delivery of construction project are provided on Table 1.

Procurement Methods in the Construction Industry:
Procurements methods in the Construction industry are classified by Babatunde (2010) as shown in Table 1.

Table 1: Procurement Methods in the Construction Industry

S/n	Procurement Methods	Functions of construction				
		Design	Build	Management	Finance	Operation
1	Traditional Method	Consultant	Contractor	Consultant	Client	Client
2	Design & Build Method	Contractor	Contractor	Consultant	Client	Client
3	Management Contracting	Consultant	Specialized Contractors	Contractor	Client	Client
4	Public Private Partnership/Joint Venture	All the functions shall be shared with parties in mutually understanding environment				
5	Direct Labour System	All the functions shall be carried out by the Client engaging and creating a direct link with professionals and tradesmen dispensing the contractor				

Source: Babatunde (2010).

Traditional Procurement System

This method is as old as the construction industry the major feature in this method is that the design process is separate from the construction, it also requires full documents before the contractor can be invited to tender for the work. The main variants of traditional procurement method are: bills of firm quantities; bills of approximate quantities; drawings and specification; schedule of rates; cost reimbursement; and labour only. The traditional method as the name implies, is a project procurement method where the three sequential phases of design, bid and build are identified as separate tasks. It is traditionally referred to as the competitively bid contract. This method allows for all contractors that fill competent to bid for projects in a free and competitive atmosphere similar to competitive market environment. In a typical traditional approach, the client initiates the project and produces a written scope statement, identifying the project's objectives and verifying the scope definition by the architect. The architect is responsible for defining the project scope in order to facilitate a clear assignment of responsibilities and to monitor the scope change control with the project team. The design team produces complete design documents before engaging the contractor, often affecting the quality by not taking into consideration build- ability, constructability and life-cycle costing.

Design and Build

This approach gives the client a single point of contact. However, the client commits to the cost of construction, as well as the cost of design, much earlier than with the traditional approach. In this method, the contracting organization is responsible for design and construction for a lump sum price. In this system of procurement, all phases of a project, from conception through design and construction are handled by the same organization. To arrive at a choice of contractor, all contractors are required to develop a design to a certain level, prepare a tender figure and submit the whole package which is termed a proposal to be evaluated to meet client satisfaction team of consultants may be needed to assess each contractor's proposal. Evaluation of tenders in this case is usually very difficult because the contractors are not working with one design tenderers are to be informed of the criteria to be used and if price is likely to be a prime factor. This form of procurement has been used for the majority of process-oriented heavy industrial project. Projects using a design-build approach are designed and constructed by a single company or a partnership of companies. Several varieties of Design-Build have evolved including Design-Build-Maintain, Design-Build-Operate-Maintain, and Design-Build-Operate-Maintain-Warrant. Each version of Design-Build provides the government or owner with one source of responsibility for the project. Design-build can be specified in many different ways based on the magnitude of the project.

Management Contracting

Management contracting is a system whereby a main contractor is appointed, either by negotiation or in competition, and works closely with the team of professionals. Also, Oyegoke (2001) opined that "in a management contract, the permanent works are constructed under a series of construction contracts placed by the management contractor after approval by the client." All physical construction is undertaken by sub-contractors selected in competitive bidding. This system usually has the main contractor called the management contractor who provides the management expertise in the construction of the project for a fee. This Manager is appointed at the inception or better still feasibility stage to join the client's team of

consultants, to help work out the design programme and site operations. He manages and co-ordinates the work packages to individual sub-contractors and equally provides on the site service, plant and equipment, amenities for the work. The fee paid to the management contractor depends on the nature and extent of the work done and not on the cost of the work. However, management contracting system is most appropriate for large and complex projects which exhibit particular problems that militate against the employment of fixed price contract procedures.

Public Private Partnership (PPP)

This procurement method refers to the collaboration between public and private sector in other to achieve financing, management or maintenance of a project or provision of a service. Public Private Partnership describes a government service or private business venture which is funded and operated through a partnership of government and one or more private sector companies. Public private partnership is regarded as a tool for infrastructural development**.** The public private partnership is an attempt by government to tap from the enormous private resources by way of diversification and letting private hands partake in the provision of fundamental government responsibility of providing basic social and infrastructural amenities several models of PPP has evolved overtime as a form of improvement and modification to it, also depending on the magnitude and nature of work to be executed.

Direct Labour System

In the direct labour system, the client engages tradesmen directly to execute projects by either using in-house personnel to design and construct or directly employ operatives to construct. By this method, the services of a contractor are dispensed with and this elimination makes the direct labour system distinct from other procurement methods. It is believed that the system is simpler; cost-effective (the contractor's profit is eliminated prudent, corruption free and provides jobs for the populace).

Factors Influencing the Various Procurement Methods in the Delivery of Commercial Building Projects

The research study conducted in Nigeria in 2013 manifested that the traditional procurement system has been commonly employed in project execution (Arogundade, 2013). This indicates that the selection of procurement method mostly affects the project performance due to difference in level of importance of different factors in the selection of procurement methods. Many selection criteria affect the choice of the appropriate procurement method for a project. For finding and selection of appropriate method understanding level of importance of different factors will provide a helping hand to public sector clients.

A study on factors affecting the performance of public procurement in Kenya focused on three major aspects of public procurement. These aspects were information technology, competency of staff and ethical issues. From the study, it has been adduced that the use of information technology, deployment of competent staff and using the fair transparent mechanism in procurement has enhanced the delivery of all procurement organizations (Muturi, 2019). Research focused on factors affecting the implementation of procurement policies in Kenya, in which study reveals about delay in procurement is due to lack of competence in staff, different procurement policies, estimated cost, size of economic projects, responsibilities of client

(Kimote&Kinoti, 2018). Manthonsi and Thwala (2012). conducted study on factors influencing the selection of procurement method in construction industry of South Africa in which the identified factors were: knowledge and influence of client in life cycle of project, nature of client, political consideration, corruption and self-enrichment, size and technical complexity of project, delivery time and time related constraints, funding arrangement, familiarity of procurement method, government policies and competition, risk allocation, client requirement and cash flow, lack of sources, market condition, unskilled labour, technology globalization. A research conducted on an appraisal of project procurement method conducted in Nigerian construction industry in which identified factors having an effect on selection of procurement were reported as: estimated cost and time at project completion, minimum time of design and construction, quality assurance, financial management and control, complexity and flexibility of design and techniques to entertain the client requirement, consultancy offered, risk avoidance, available information at project inception, nature of project and client (Babatunde *et al.,* 2010).

A research work conducted by Nabil and Osama (2017) in Gaza on the selection of accurate it is indicated that the most affected six factors involved in the adoption of accurate procurement methods in the construction of projects are cost competition, degree level of complexity project, time criteria of the project, size of a project, financial capability of client and experienced client in procurement system. Furthermore, studies conducted by Osama (2013), Shirley and Lin (2014), Arogundade (2013), and Doloi *et al*. (2008) also addressed the selection of procurement. Based on literature cited above, this study considered various factors which relating with the Nigerian environment and construction industry which mainly affect the selection of procurement and for further investigation in context of set objective.

The factors influencing the selection of procurement methods were considered and categorized from the above review of literature as follows:

A. Category-1: Client characteristic related factors
a. Financial capability of client
b. Client experience in procurement method
c. Availability of qualified personnel
d. Integrated Design and Construction
B. Catgory-2: Time related factors
a. Project completion at estimated time
b. Construction time
c. Delivery time Schedule
C. Catgory-3: Cost related factors:
a. Project completion at estimated cost
b. Cash flow and Funding Arrangement
c. Price certainty
D. Catgory-4: Quality related factors
a. Quality Certification
b. Experience of project contractor
c. Required level of quality control
d. Expected performance of project
E. Category-5: Other related factors

a. Procurement Policy
b. Size of Project
c. Market Condition
d. Economic condition
e. Availability of resources

METHODOLOGY

This research focuses on factors influencing procurement methods on commercial project delivery. The study adopted the quantitative survey research approach. For the purpose of this study, data were collected with the aid of a well-structured questionnaire which were self-administered to construction professionals involved in the usage of various procurement methods in Abuja.

The targeted population of respondents for this research constitutes building industry professionals (Architects, Quantity Surveyors, Builders and Engineers) in selected Federal Capital Development Authority (FCDA) in Abuja. This selection was made because they are highly staffed and are involved in majority of the commercial buildings in Abuja. FCDA has a unit responsible for procurement and the criterion for selecting the professionals was their involvement in the procurement and construction process of commercial buildings. This study employed the use of purposive sampling technique to select the respondents that were used for the research. The population size was estimated at 194 consisting of construction professionals and sample size estimated at 130 using Yamane (1967) formula. A total of 130 questionnaires were administered after which 95 were returned which is a 73% response rate. Analysis of data was carried out using Relative Importance Index (RII) which was employed to examine the factors influencing the various procurement methods in the delivery of commercial building projects in Abuja in order of importance to achieve aim of the study. Data processing was done with the aid of Statistical Package for the Social Sciences (SPSS 2) software version.

RESULTS AND DISCUSSION

From Table 2, it was shown that out of the nineteen (19) factors influencing the various procurement methods in the delivery of commercial building projects in Abuja identified from review of literature, four (4) factors are very important. These are Project Completion at Estimated Cost, Cash flow and Funding Arrangement, Financial Capability of Client and Expected Performance of Project with RII of 0.91, 0.90, 0.89 and 0.80 respectively. The remaining fifteen (15) factors are important with RII ranging from 0.79 (Size of Project) to 0.61(Quality Certification). On the average, the factors influencing the various procurement methods in the delivery of commercial building projects in Abuja are important (average RII = 0.76).

This is in line with the finding of Nabil and Osama (2018) who stated that project completion at estimated cost, cash flow, cash flow and funding arrangement, expected performance of project in relation to project characteristics and financial capability of client in relation to client's characteristics are highly important factors in influencing the selection of procurement methods. It is also in line with the findings of Babatunde. (2010) and Nabil and Osama (2017) where they listed estimated cost at project completion, financial management and control and financial capability of client as key factors influencing accurate procurement strategy.

Table 2: Summary of the results of factors influencing procurement methods in the delivery of commercial building projects in Abuja.

S/No.	Factors Influencing Procurement Methods	RII	Rank	Decision
1	Project Completion at Estimated Cost	0.91	1st	Very Important
2	Cash flow and Funding Arrangement	0.90	2nd	Very Important
3	Financial Capability of Client	0.89	3rd	Very Important
4	Expected Performance of Project	0.80	4th	Very Important
5	Procurement Policy	0.79	5th	Important
6	Size of Project	0.79	5th	Important
7	Clients Experience in procurement	0.77	7th	Important
8	Market Condition	0.77	7th	Important
9	Economic Condition	0.77	7th	Important
10	Required Level of Quality Control	0.76	10th	Important
11	Experience of Project Contractor	0.75	11th	Important
12	Construction time	0.75	11th	Important
13	Availability of Resources	0.73	13th	Important
14	Price Certainty	0.72	14th	Important
15	Availability of Qualified Personnel	0.70	15th	Important
16	Project Completion at Estimated time	0.70	15th	Important
17	Delivery and Time Schedule	0.70	15th	Important
18	Integrated Design and Construction	0.67	18th	Important
19	Quality Certification	0.61	19th	Important
	Average RII	0.76		Important

Source: Researcher's Analysis of Data (2020)

CONCLUSION AND RECOMMENDATION

This study reveals that all factors influencing the procurement methods in commercial project delivery are important, with varying levels of importance where some have higher relative importance index than the other, Project Completion at Estimated Cost, Cash flow and Funding Arrangement, Financial Capability of Client and Expected Performance of Project are having the most influence on procurement methods in commercial project delivery while the other 15 factors having lower importance levels with Quality Certification being the lowest. This indicates that these factors seem to determine the procurement method that will be employed for a commercial project which will affect the project procurement process during project actualization and further affect the project performance and delivery. It can be concluded that the factors influencing the procurement methods are important in procurement selection process of commercial building projects in Abuja. Therefore, proper attention should be paid to these factors in relation to the construction environment or construction purpose as it will partly determine the success or failure of the project delivery. Professionals should also properly advise clients on the appropriate procurement method for the execution of commercial building projects in order to avoid problem with time, cost and quality associated with the project.

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Assessment of Procurement Risks in FIRS Building Construction Projects in Nigeria

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Abstract:

The procurement system practiced by the FIRS is constantly challenged with the problems of fraudulent practices, inefficiencies, lack of transparency, professionalism, and non-adherence to procurement code of ethics. This study assessed the procurement related risks in FIRS building construction projects in Nigeria with a view to minimising the problems of fraudulent practices. The study adopted a quantitative approach using structured questionnaires, which were randomly distributed to clients, procurement officers, contractors and consultants of FIRS building projects. The collected data was analysed using percentile, frequencies and Relative Importance Index. The study categorised risks in FIRS procurement into five major groups and found the important risks factors under each group. The top risks factors under 'Fraud' were: Kick back, shadow vendors, changes in the bids after formal receipt, suspicion about conflict of interest, and conspiracy amongst bidders. The top risks factors under 'transparency problems' were: dishonesty and lack of openness of staff to bidders, non-adherence to award criteria, and improper advertisement of proposal requests. The top risks under 'competitiveness problems' were: lack of competition among tenderers and limited issuance of eligibility forms. On the overall, the top procurement related risks were: Kick back, lack of cost-effective tenders among the bidders, shadow vendors, changes in the bids after formal receipt, and suspicion about conflict of interest. It is recommended that a system of checks and balances is put in place in FIRS project to forestall the inherent corruption. Also, contractors and consultants with integrity should be engaged in FIRS projects.

Keywords: Public building, Procurement Risk, Risk management, and FIRS

INTRODUCTION

Traditionally, government has full control over infrastructure financing in Nigeria, until 1980s, when reforms were introduced to confront the dwindling oil revenue that challenged state capacity for infrastructure provision (Animashaun, 2011). The 2015 economic downturn in Nigeria has necessitated the adoption of more prudent methods of delivering construction projects. Thus, procuring entities of the government are faced with the challenge of effectively procuring projects within the meagre budget of the government (Osanyinro and Aghimien, 2017). The African Development Fund (ADF) found that government agencies will often rank potential projects in accordance with their benefit cost ratio and build facilities as money becomes available. Procurement of projects by meeting the delivery time, cost, and quality constraints has continued to be a challenge to the design team, the contractors and managers of the investments. Thus, the grounds of procurement method is gradually shifting from just meeting clients' needs into apportionment of risks, as the contractors are gradually taking their stance as business organisations with the aim of making optimum profits at minimum risks (Babatunde *et al.*, 2010).

Saruchera (2016) disclosed that until recently, procurement was seen as a necessity only, which in many developing economies the profession is still being treated as a 'back-office' function. However, the International Training Centre of the International Labour Organisation (ITCILO) in 2017 explained that public procurement has for long been overshadowed with inefficiency, corruption and disregard of fundamental "value for money" considerations. The public procurement has also adversely impacted the rate and quality of progress in realising the

objectives of national development, especially in developing and transition countries. Russell and Meehan (2014) noted that public procurement is an obligation to deliver value to its citizens, and are held accountable through complying with regulation, responsible spending of the public purse, and ensuring the third-party delivery of contracted goods and services. Such obligations or efficacy of regulatory frameworks are rarely challenged and the impact of procurement activity is under-researched. A study conducted by Uyarra *et al.* (2014) highlighted numerous barriers which prevent public organisations from delivering innovation and policy outcomes to includes lack of market engagement by procurement, poor tendering practice, low procurement competence and lack of risk management. Therefore, the risk management framework applied to procurement involves risk anticipation, risk monitoring and risk mitigation (Okonjo, 2014).

Consequently, understanding the main categories of risk faced in the procurement process will assist in risk assessment and planning, and devising the management and operational measures that will be taken to mitigate those risks (United Nations Procurement Practitioners Handbook, 2012). For this reason, effective procurement risk management practice requires an understanding of the relationship between procurement and organisational objectives (Okonjo, 2014). Hence, Murray (2013) observed that procurement related risks have not reduced and the FIRS projects are being delayed unnecessarily which Chen (2018) attributed to poor understanding of risks and its management strategies by the organisations.

It is therefore important to understand that risk occur at different stages of the procurement of Federal Inland Revenue Service (FIRS) building construction projects, hence the need to undertake a study to assess the risks in procuring FIRS building projects in Nigeria.

PROCUREMENT RELATED RISKS IN PUBLIC BUILDING PROJECTS

The management of risk in the procurement cycle is crucial in the realisation of project objectives. This is reinforced by the works of many researchers in public sector procurement (Ogunsanmi, 2013). The procurement cycle is characterised by a lot of risk (Abdul-razak, 2013). It is important to note that the slightest error or inconsistency in conducting procurement processes or activities can lead to accusations (Barden, 2010). Barden (2010) further argues that, even if these accusations are ultimately proven to be without merit, they can cause significant and lasting damage to the reputation of an individual and procurement agency. It is unfortunate that buyer and supplier often undertake procurement without risk considerations and sometimes the risk in itself (Gilbert and Anthony, 2016). This way procurement requires risk management plans to be put together for each procurement and to establish what risks are present and the means to reduce or eliminate (Abdul-razak, 2013).

In Nigeria, the major risk in the procurement of public buildings include lack of transparency, competitiveness, corruption, problems of cost effectiveness and professionalism in the execution of procurement functions (FGN, 2007).

Fraud as a risk in public procurement

Procurement fraud can be defined as dishonestly obtaining an advantage, avoiding an obligation or causing a loss to public property or various means during procurement process by public servants, contractors or any other person involved in the procurement (Basweti, 2013). An example is a kickback, whereby a dishonest agent of the supplier pays a dishonest

agent of the purchaser to select the supplier's bid, often at an inflated price (http://everything.explained.today/Procurement). Other frauds in procurement include: Collusion among bidders to reduce competition, providing bidders with advance "inside" information, Submission of false or inflated invoices for services and products that are not delivered or work that is never done. "Shadow vendors", shell companies that are set up and used for billing, may be used in such schemes (Colman, 2016)

Lack of transparency as a risk in public procurement

The term procurement transparency implies openness in procurement processes, procedures and adherence to lay down rules. Corruption in construction contracts is becoming widespread due to lack of transparency in procurement and project delivery process (Oyegoke, 2012).

The UN Office on Drugs and Crime (UNODC) states that a procurement system that lacks transparency and competition is the ideal breeding ground for corrupt behaviour (UNODC, 2013). In another contribution by Komakech (2016), transparent procurement procedures can contribute to a more efficient allocation of resources through increased competition, higher quality procurement and budgetary savings for governments and thus for taxpayers.

i. Transparency, which has long been accepted as a tool for tackling corruption through a number of international agreements, is also an effective tool in addressing challenges SMEs face in public procurement (Kaspar and Puddephatt, 2012). Without transparency, “open competition cannot prevail, corrupt dealings can proliferate, and other failings in the procurement process may be covered up, so weakening accountability” (Jones et al., 2009).

ii. Greater transparency in public procurement

iii. Transparency can improve access to public procurement opportunities through disclosure, publication and dissemination of information on available tenders (Ahmed, 2019). Drawing on examples of good practice, e-procurement stands out as the most commonly employed tool to improve transparency in public procurement (Kaspar and Puddephatt, 2012). According to Scott and Julius (2015) lack of transparency in the award of government contract was among the several factors listed that attributed to the failure of public procurement system in Africa.

Lack of professionalism as a risk in public procurement

This section presents the risks that relate to professionalism in building projects. According to Kalinzi (2014) professionalism in public procurement allows for functionality, transparency and significant savings in public expenditure and this partly explains why it should be given due attention. There is a number of indicators that clearly guide the path to professionalism and these include legislative framework, institutional framework, professional staff transparency and modernisation procedures like use of information and communications technology among other adequacies. Globally, there are recognised bodies that have championed professionalism in various related disciplines. These include the Chartered Institute of Purchasing and Supply (CIPS), Chartered Institute of Logistics and Transport (CILT), The Dutch Association for Purchasing Management (NEVI) (Kalinzi, 2014).

This is in line with the finding of Nabil and Osama (2018) who stated that project completion at estimated cost, cash flow, cash flow and funding arrangement, expected performance of project in relation to project characteristics and financial capability of client in relation to client's characteristics are highly important factors in influencing the selection of procurement methods. It is also in line with the findings of Babatunde. (2010) and Nabil and Osama (2017) where they listed estimated cost at project completion, financial management and control and financial capability of client as key factors influencing accurate procurement strategy.

Lack of competitiveness as a risk in public procurement

Competitiveness refers to the active participation of the private sector and or contractors in the procurement process through the making of procurement information accessible to all; through advertising of tenders; sourcing reviews; prequalification and the adoption of transparent procedures in the procurement systems. The benefits of competitiveness cannot be overemphasized and includes potential savings for the economy; increases in the supplier base; and the development of the local industries within the economy and thereby eventually leading to economic development and poverty reduction. Competition underpins the pillars of fairness and transparency, and is the primary driver of Value for Money (VFM) in virtually all procurement (Office of Government Commerce (OGC), 2008).

RESEARCH METHODOLOGY

This research adopted a survey design approach utilising the quantitative method in the form of a well-structured questionnaire survey for management of risk in procurement of FIRS building construction projects in Nigeria.

The population for this study constituted the client, contractors and consultants who have participated in procurement activities of FIRS building projects in Nigeria. These comprised 211 participants. The sample frame for this study consist of Procurement staff of FIRS = 64, Facility/Project Manager of FIRS = 89, Consultants (QS=5, Arc=4, Builder=6, Engineer=6, Project manager=5) = 26 and Contractors = 32. These totalled to 211 respondents for the questionnaires.

Because of large number of the sample size, the number was subjected to Taro Yamane formula for finite population. The 211 was then reduced to 138 at 5 percent limit of error and at 95 percent confidence level. For the purpose of this research, the sample size was 138 respondents, which is the minimum sample size for this research. A total of 138 questionnaires were distributed in the course of this study. 112 questionnaires were retrieved out of the number distributed and 108 were found valid for the analysis, as 4 were discarded as a result of incomplete responses. The 108 represents an effective response rate of 78.26%.

In order to guarantee equal representation for each of the identified groups of professionals in the population, stratified random sampling method was adopted for the research. The respondents were first categorized into different strata/groups, that is: Clients, Contractors and Consultants before they were selected and randomly sampled accordingly.

The questionnaire asked questions on a 5-point Likert scales. The questionnaire was divided into two (2) main parts. Part A - is related to demographic information of the respondents and their functions in the organisations. Part B- was related to procurement risks in FIRS building

construction project. 5- Most Frequent, 4-Frequent, 3-Fairly Frequent, 2-Undecided, 1-Not Frequent

For the purpose of this research, primary data was collected through quantitative research approaches which included the use of well-structured questionnaires. Since the research is a quantitative approach, the method of data analysis in this research was descriptive in nature, and this included Relative Importance Index (RII); and Ranking methods. The demographic information of respondents was analysed using frequency and percentile.

RESULTS AND DISCUSSION

Demographic information of the respondents

Result in Table 1 shows that most of the respondents are 67.59% male while 32.41 % are female. In terms of professionals' representation, the result revealed that Quantity Surveyors more with 36.11%, followed by Engineers (23.15%), Architects (13.89%), Project Managers (13.89%) and Builders (12.96%).

Table 1: Demographic information of the respondents

Category	Variables	Frequency	Percentage
Gender	Male	73	67.59%
	Female	35	32.41%
	Total	108	100%
Profession	Architects	15	13.89%
	Builders	14	12.96%
	Engineer	25	23.15%
	Quantity Surveyors	39	36.11%
	Project Managers	15	13.89%
	Total	108	100%
Years of Experience	Less than 5years	17	15.74%
	5-10years	30	27.78%
	11-20years	36	33.33%
	21-30years	19	17.59%
	Above 30	6	5.56%
	Total	108	100%
Academic qualification	ND	6	5.56%
	HND	23	21.30%
	BSc/BTech	58	53.70%
	MSc/MTech	14	12.96%
	Others	7	6.48%
	Total	108	100%
Function in the Organisation	Consultant	31	28.70%
	Contractors	41	37.96%
	Project/Facility manager	15	13.89%
	Procurement Officer	21	19.44%
	Others	0	0.00%
	Total	108	100%

Source: Researcher's analysis (2019).

A look at the year of work experience of the respondents shows that only 15.74% of them have their year of working experience to fall within less than 5 years range, while 27.78% and 33.33% falls between the range of 5 to 10 and 11 to 20 years respectively. Also 17.59% and

5.56% of the population falls between the ranges of 21 to 30 years and above 30 years respectively. However, the average years of working experience of the respondents is calculated as approximately 10.75 years. This implies that they are experienced enough to give a valid response.

In terms of academic qualification, the highest is BSc/MTech (53.70%), followed by HND (21.30%), then MSc./MTech (12.96%), ND and Others are 5.56% and 6.48% respectively.

The functions in the organisations shows that 28.70% are consultants, 37.96% are contractors, project/facility manager, and procurement officers are 19.44%.

Based on the result on the respondents' background information, it was concluded that the respondents are well equipped professionally and in terms of experience to give reasonable insight in the subject under consideration.

Procurement Related Risks in FIRS Building Construction Projects

Table 2 shows the result of the analysis of the procurement risks associated with FIRS building construction projects. It can be seen that the top five (5) procurement risks under the Fraud as a risk factor in procurement group are; Kick back (contractor given out money to procurement officials) (RII=0.98), Shadow vendors (submission of inflated invoices for work not delivered) (RII = 0.89), Changes in the bids made after their formal receipt (RII=0.88), Suspicion about conflict of interest (RII=0.87), and Conspiracy amongst bidders to reduce competition (RII=0.86). Under the problems of transparency as a risk in procurement, the top risks factors are; Dishonesty and lack of openness of staff to bidders in procurement process (RII=0.81), Non-adherence to award criteria (RII=0.80), and Improper advertisement of proposal requests (RII=0.77).

For the Professionalism as a risk in procurement, the top risks are; inadequate skill-based and theoretical knowledge of the procurement staff (RII=0.84), and Unclear definition of specifications (RII=0.84). The Competitiveness as a risk in procurement group, shows that lack of competition among tenderers (RII=0.84), and limited issuance of eligibility forms (only to favoured/selected contractors) (RII=0.77), are the top risks factors. Under the Problems of cost effectiveness as risk in procurement, the top risks factors are; Lack of cost effective tenders among the bidders (RII=0.96), In adequate detailed engineering activities (RII=0.86), and Over-estimated quantities of work items (RII=0.78).

Overall, the top five procurement related risks are; Kick back (contractor given out money to procurement officials) (RII=0.980, Lack of cost effective tenders among the bidders (RII=0.96), Shadow vendors (submission of inflated invoices for work not delivered) (RII=0.89), Changes in the bids made after their formal receipt (RII=0.88), and Suspicion about conflict of interest (RII=0.87). The least procurement related risks are; Inadequate justification for single source procurement (RII=0.68), Over -estimated construction duration (RII=0.65), Discrimination or favouritism by any clause in the contract (RII=0.62), Very limited number of offers received (RII=0.56), and Non-adherence to procurement laydown rules and regulations (RII=0.51). These findings are in line with the conclusion of Jones et al. (2009) on the risks factors in procurement system. Some of these findings are also in line with the statement that the major risk in the procurement of public buildings In Nigeria, include lack of

transparency, competitiveness, corruption, problems of cost effectiveness and professionalism in the execution of procurement functions (FGN, 2007)

Table 2: Procurement related risks in FIRS building projects

S/N	Procurement related risks	RII	Rank	Overall Rank
A	Fraud as a risk factor in procurement			
1	Kick back (contractor given out money to procurement officials)	0.980	1	1
2	Conspiracy amongst bidders to reduce competition	0.852	5	7
3	In-house information leakages to bidders	0.798	10	18
4	Shadow vendors (submission of inflated invoices for work not delivered)	0.887	2	3
5	Eligibility envelopes received beyond the deadline set for submission	0.796	11	19
6	Boycotting observers to be invited	0.796	11	19
7	Splitting of contracts	0.728	13	29
8	Suspicion about conflict of interest	0.867	4	5
9	Lowest responsive bidder not selected	0.850	6	8
10	Changes in the bids made after their formal receipt	0.883	3	4
11	Unusual involvement of procurement official in the contract documents	0.698	15	34
12	Evidence of early receipt of information by some contractors	0.722	14	30
13	Unusual handling of the bidding process	0.828	8	13
14	Inconsistent evaluation criteria for different bidding process	0.826	9	14
15	Exceptions to the tender deadlines	0.830	7	12
16	Inadequate justification for single source procurement	0.680	16	37
17	Discrimination or favouritism by any clause in the contract	0.617	17	39
B	Problems of transparency as a risk in procurement			
1	Dishonesty and lack of openness of staff to bidders in procurement process	0.807	1	16
2	Non-adherence to procurement laydown rules and regulations	0.515	7	41
3	Inadequate publicity (advertisement of procurement procedures for tenders)	0.720	5	31
4	Non-availability of technical specifications to all tenderers	0.696	6	35
5	Non-adherence to selection criteria of tenderers	0.743	4	25
6	Non-adherence to award criteria	0.802	2	17
7	Improper advertisement of proposal requests	0.769	3	23
C	Professionalism as a risk in procurement			
1	Inadequate skill-based and theoretical knowledge of the procurement staff	0.844	1	9
2	Inadequate training of procurement staff	0.824	3	15
3	Non-adherence to procurement code of ethics	0.720	4	31
4	Lack of professional membership of procurement staff	0.696	5	35
5	Unclear definition of specifications	0.843	2	10
D	Competitiveness as a risk in procurement			
1	lack of competition among tenderers	0.839	1	11
2	Limited issuance of eligibility forms (only to favoured/selected contractors)	0.770	2	22
3	Non-posting of the Invitation to Apply for Eligibility and to Bid (IAEB) in a newspaper of general nationwide circulation	0.730	4	27
4	Inadequate posting of the IAEB	0.735	3	26
5	Very limited number of offers received.	0.565	5	40
E	Problems of cost effectiveness as risk in procurement			
1	Lack of cost effective tenders among the bidders	0.959	1	2
2	In adequate detailed engineering activities	0.865	2	6
3	Over-estimated quantities of work items	0.778	3	21
4	Over-estimated construction duration	0.648	7	38
5	Excessive prices of materials	0.763	4	24
6	Excessive labour or equipment rental rates	0.709	6	33
7	Price escalation granted not in accordance with the prescribed formulae	0.730	5	27

CONCLUSION AND RECOMMENDATIONS

This study was set to assess the procurement related risks in FIRS building construction projects in Nigeria with a view to minimising the problems of fraudulent practices. The study concludes that procurement risks in FIRS building projects are found under Fraud, transparency, professionalism, competitiveness and cost effectiveness. The study also concludes that the common procurement related risks in FIRS building projects are: kick back, lack of cost effective tenders among the bidders, shadow vendors, changes in the bids after formal receipt, and suspicion about conflict of interest. It is concluded that effective management of the identified risks factors would translate into reduction in the rate of procurement fraud in FIRS building projects. It is recommended that a system of checks and balances is put in place in FIRS project to forestall the inherent corruption. Also, contractors and consultants with integrity should be engaged in FIRS projects.

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Assessment of the Adoption of Building Information Modelling (BIM) in the Nigerian Construction Industry

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Abstract

Despite the use of BIM being an indicator of the maturity of a nation's construction industry as well as conferring several benefits on project stakeholders, researchers have noted that awareness of BIM among Nigerian construction professionals is low. This study aimed to assess the adoption of BIM on projects carried out by construction firms in the Nigerian Construction Industry (NCI). The study adopted a quantitative research design that was based the use of questionnaires. A convenience sample of relevant professionals in construction firms who could be accessed through an online survey was built up through a snowballing approach, which eventually yielded a total of 52 professionals. The data gathered from this sample through a questionnaire survey was analysed using descriptive statistical method (Mean Item Score and Standard Deviation) and the results were presented using tables and charts. The study found that BIM awareness and acceptance are at a medium level; only 'AutoCAD' BIM software enjoyed a 'High' frequency of use in the NCI. BIM adoption had a noticeable impact in four reviewed aspects of project performance; 'Greater control', 'Improved collaboration', 'Conflict resolution', and 'Reduction in labour'. The study concluded that BIM use in the NCI is still at a rudimentary level, although great potential for improvement exists, if the right environment (political, legislative, contractual, and technical) is provided. It was recommended that the Federal and State governments should devise an Implementation Strategy Plan for BIM; in addition, Clients could subsidise BIM costs through Preliminaries items on high-value construction contracts.

Keywords: adoption, Building Information Modelling, construction, technology.

INTRODUCTION

The construction industry is one of the major industries contributing significantly to national economies, in terms of GDP. Despite this fact, the industry is not maximising its full potentials. This has been attributed to some factors, among which is the fragmented process of design, procurement, construction, and project delivery (Khalfan and Anumba, 2000). The construction industry in Nigeria grapples with the challenges in form of time overrun, cost overrun, high level waste, high labour cost, variations/claims, inadequate control of the construction process, lack of seamless collaboration between agents, conflicts and clashes, as well as high level of errors and risks (Manza, 2016). Yusuf *et al*. (2015) cited the works of other authors that revealed that BIM has the potential to significantly change and improve performance and documentation in the construction industry. It is expected that the use of BIM will achieve decreased project costs, increased productivity and quality and reduced project delivery time.

Building Information Modelling (BIM) is a modern building delivery technology which is embraced by the construction industry globally (Yusuf, Ali & Embi, 2015). Internationally, the building industry is transforming rapidly with the introduction of BIM (Onungwa & Uduma-Olugu, 2016). BIM is a digital model full of information for the purpose of construction and management of the project throughout its life cycle (Yusuf *et al*., 2015); in fact, it is a digital representation of physical and functional characteristics of a facility (Building SMART, 2010).

Quite a number of studies on BIM in the Nigerian construction sector have been attempted; some of these studies focused on areas such as BIM and life cycle of the project (Onungwa &

Uduma-Olugu, 2017), BIM and adoption factors for construction industry in Nigeria, (Mohammad *et al*, 2018), contractors' perception of BIM implementation in Nigeria (Abubakar, Ibrahim, Kado and Bala, 2014). This research is about relating the adoption of BIM to the effects it has on the Nigerian construction industry (NCI). The specific objectives are to (i) ascertain the level of BIM adoption in the Nigeria Construction Industry, and (ii) determine the effect of BIM level of adoption on the management of construction projects.

LITERATURE REVIEW

Building Information Modelling (BIM)

According to Autodesk, the developer of various Building Information Modelling (BIM) tools, "BIM (Building Information Modelling) is an intelligent 3D model-based process that gives architecture, engineering, and construction (AEC) professionals the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure" (Autodesk, 2017).

Building Information Modelling (BIM) is an innovative approach in architectural, engineering and construction industry as a modelling technology which encompasses AEC digital data throughout the construction life cycle (Mohammed *et al.*, 2018). Building information Modelling (BIM) is one of such innovative processes that is already bringing about continuous improvement and desired change in the construction industry by revolutionizing operational processes to achieve better collaboration between project parties. BIM stimulates the construction activities in a virtual environment. With BIM technology, an accurate virtual model of a building known as Building Information Model is digitally constructed and used to support the design, procurement, fabrication and physical site construction activities required to realize the structure (Abubakar *et al*., 2014).

BIM has also been described as the digital representation of the physical and functional characteristics of a facility, which serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle from inception onward (Building SMART, 2010). According to Ibrahim and Abdullahi, (2016), BIM is the most recent technological innovation developed to support designs, construction and operation of building and engineering projects in a virtual environment using intelligent objects. With BIM, both 2D and 3D drawings can be created as by-products of its design process. Design views can automatically be generated from single foundational database; and all other form of analysis such as clash detection, constructability analysis and more, can be undertaken in a BIM environment.

Globally, BIM has already existed for more than twenty years (Hadzaman, Roshana, & Nawawi, 2015). Many developed economies of the world have recorded impressive outcomes by implementing BIM in their construction practices (Abubakar *et al*., 2014). The idea of BIM was led by the United States (Smith, 2014). United Kingdom (Waterhouse and Philip, 2016); Norway, Finland and Denmark (Smith, 2014), are other leaders in BIM adoption and implementation.

There are so many professional BIM softwares available in the market today complying with all digital delivery requirements. Some of the BIM softwares are listed in Table 1:

The Levels of BIM

According to McPartland, (2014), the government of UK has recognised that the process of moving the construction industry to "full collaborative working" will be progressive, with distinct and recognisable milestones being defined within that process, in the form of "levels". They have been defined within the range from 0 – 3, and whilst there is some debate about the exact meaning of each level, the broad concept is as follows:

Level 0: describes unmanaged CAD (Computer Aided Design). This is likely to be 2D, with information being shared by traditional paper drawings, or in some instances, digitally via PDF, essentially separate sources of information covering basic asset information (bimblus.co.uk). Level 0 in its simplest form means no collaboration. 2D CAD drafting only is utilised, mainly for production information (RIBA Plan of Work, 2013 stage 4). Output and distribution is via paper and electronic prints, or a mixture of both. Majority of the industry is already well ahead of this now (Waterhouse, 2017).

Table 1: Some BIM software and their uses

BIM Software	Description of software
ARCHICAD	Architectural BIM CAD software that offers computer aided solutions for handling all common aspects of aesthetics and engineering during the whole design process of the built environment.
Vector works	2D drafting, 3D modelling, BIM and have rendering capabilities. A design software that delivers a flexible and collaborative design process to architecture, landscaping and entertainment professionals
Autodesk Revit	Revit is BIM software offering a multi – disciplinary and collaborative approach to design and construction projects. Revit empowers the AEC practitioners to produce a consistent, coordinated, and complete model – based designs for buildings and infrastructure
Navisworks	3D design review that combine design and construction data into a single model. Identify and resolve clash and interference problems before construction.
Sketch up	Premier 3D modelling computer programme for a wide range of drawing application
Allplan	3D BIM design and detailing software for precasters, rebar retailers and civil and structural engineers.
Others include	BricsCAD, Autodesk Ecotect Analysis, Microstation, Archibus, Green Building, Bentley Systems

Sources: Vectorworks.net, (2017); Autodesk.com, (2017)

Level 1: Involves managed CAD in 2D or 3D, it is a mix of 2D and 3D information using BS 1192 with a collaboration tool providing a Common Data Environment (CDE), (Mordue, 2019). BIM level 1 typically comprises a mixture of 3D CAD for concept work, and 2D for drafting of statutory approval documentation and production information (McPartland, 2014). CAD standards are managed to BS 1192:2007 and electronic sharing of data is carried out from a CDE often managed by the contractor.

Level 2: The concept of BIM levels and BIM level 2 compliance has become the accepted definition of what criteria are required to be deemed BIM-compliant, by seeing the adoption process as the next steps in a journey that has taken the industry from the drawing board to the

computer and ultimately into the digital age (McPartland, 2014). This involves developing building information in a collaborative 3D environment with data attached, but created in separate descriptive models. (bim-level2.org, 2020) provides a one stop – shop access to the level 2 standards including PAS 1192. It is distinguished by collaborative working and requires an information exchange process which is specific to that project and coordinated between various systems and project participants.

Any CAD software that each party uses must be capable of exporting to one of the common files formats such as Industry Foundation Class (IFC) or COBIE (Construction Operations Building Information Exchange). This is the method of working that has been set as a minimum target by the UK government for all work on public sector work. BIM level 2 involve a series of domain and collaborative federated model. The models consisting of both 3D geometrical and non – graphical data, are prepared by different parties during the project life cycle within the context of a common data environment. Using proprietary information exchanges between various systems, project participants will have the means necessary to provide defined and validated outputs via digital transactions in a structured and reusable form (bim-level2.org, 2020).

Level 3: Has yet to be defined in detail, but it is thought that it will include a single, collaborative, online, project model including construction sequencing, cost and management information. The latest Government Construction Strategy (GCS) by the UK government published in March, 2016 seeks to embed BIM level 2 across departments which will in turn enable departments to gradually move to BIM level 3 (bimplus.co.uk, 2020).

BIM Adoption and Implementation

BIM advancement in the Middle East is on the rise (Gerges *et al*., 2017). United States has recorded the most significant development in construction digitalization, Australia, United Kingdom and some other developed nations are also amongst promoters of BIM process and its development. Recently, developing countries like China and Malaysia are keying into the industry's digital shift, while very little move is seen in South Africa whose development is considered higher and perhaps leader in the digital transition amongst the African countries (Hamma – Adama & Kouieder, 2018). Countries have been adopting BIM at different levels and with different purposes, having different experiences (in benefits), depending on adoption level and possibly their challenges earlier to the adoption. According to Kori & Kiviniemi, (2015), countries like Finland, USA, UK, Australia, Netherlands, Singapore, Hong Kong Norway, Denmark among others have adopted BIM technologies and have experienced significant benefits in construction project delivery (Yan & Damian, 2008; Isikdag & Underwood, 2010; Nederveen *et al*, 2010; Sebastian & Berlo, 2010).

Despite the potentials and documented benefits, not much has been reported regarding its implementation in the Nigerian AEC industry. BIM concept can be traced mostly in Architectural practices than engineering practices in Nigeria. A superficial BIM practice is found to be at organizational level only and operating a model based - "BIM Level 1" (Abubakar *et al*., 2014).

BIM Benefits and Barriers

Table 2 presents some of the identified barriers to adoption of BIM in the construction industry in Nigeria.

Table 2: Barriers to adoption of BIM

Process Barriers	Technology Barriers
High cost of Training expenses and the learning curve are too expensive	Lack of trained professionals to handle the tools
Social and habitual resistance to change	Lack of BIM experts
Legal and contractual constraints	High Maintenance costs
Lack of enabling environment (Government policies and legislations)	High Cost of integrated software/models for all professionals
Clients not requesting the use of BIM on projects	Poor internet connectivity
No proof of financial benefits	frequent power failure
Lack of standards to guide implementation	
lack of awareness of the technology among industry	

Sources: Ahmed and Houque, (2018); Abubakar *et al*., (2014); Ibrahim and Abdullahi (2016)

Some of the benefits of BIM technologies as claimed by its proponents are the provision of an efficient communication and data exchange system (Nederveen *et al.*, 2010), auto quantification, improved collaboration, coordination of construction documents, improved visualisation of design (Olatunji *et al*., 2010; Sacks et al., 2010), clash detection and cost reduction (Eastman *et al*., 2011) among others. Okereke, Chukwujindu and Emenike (2019) list the various benefits that can be derived from using BIM to include: better coordination, synchronization and sequencing of projects, and allowing all project participants to access and interrogate project information. At an advanced level, BIM enables better clash detection, ability to visualize what is to be built in a simulated environment, higher reliability of expected field conditions, allowing for opportunity to do more prefabrication of materials off site. The building design development can continue with the provision of automatic bills of material and generation of automatic shop drawings for everything from structural steel to sheet metal duct fabrication, to fire protection and piping fabrication, to electrical cabling and bus duct layouts.

METHODOLOGY

This study adopted a questionnaire survey research design approach. A structured questionnaire was designed in three sections, using Likert-scale response options. Data was collected through a convenience sampling of the professionals in the construction firms in some states who were accessed remotely through electronic means. A total of 52 professionals were sampled. The study was limited to construction professionals who perform project design/supervision/management roles on building projects. It is believed that they have adequate knowledge about the state of BIM in building construction practice in Nigeria and can answer the questions of this study.

The questionnaire data was analysed using descriptive statistical method (Mean Item Score and Standard Deviation), which allowed the ranking of awareness, adoption and effects of BIM in building projects. A 5-item Likert scale was used to obtain perceptions of BIM adoption from respondents, from which Mean Item Scores (MIS) were computed. These MIS were then used to rank the different aspects of BIM adoption. For adoption of any aspect of BIM to be considered 'high', it must have an MIS of 3.50 – 4.49; to be considered 'very high', the MIS value must lie between 4.50 and 5.00. All of the results of these analyses were presented in Tables.

RESULTS AND DISCUSSION

Results of Demographic Analysis of Respondents

Quantity surveyors were the most numerous of the professionals sampled, comprising 56% of the sample. Other major subgroups of professionals included architects (19% of the sample), builders (7%), engineers (6%) and project managers (4%). The implications of the spread of the professions of respondents in this study include the probability of the views of quantity surveyors dominating that of other professionals. It also shows that key professions in the actual building construction process were covered in the survey. This result is presented in Figure 1. The second pie-chart which is labelled Figure 2 provided information relating to the extent of experience acquired by the respondents. There were no respondents who had worked for less than 2 years; those who had worked for between 2 and 5 years comprised 29% of the sample. A further 40% of the sample had worked for between 5 and 10 years; respondents who had acquired between 10 and 15 years' experience made up 21% of the sample. Very experienced professionals, possessing more than 15 years of work experience, comprised 8% of the sample. From these results it was apparent that the respondents were professionals who had worked sufficiently enough to have experienced the use of BIM if it had been adopted in the organizations.

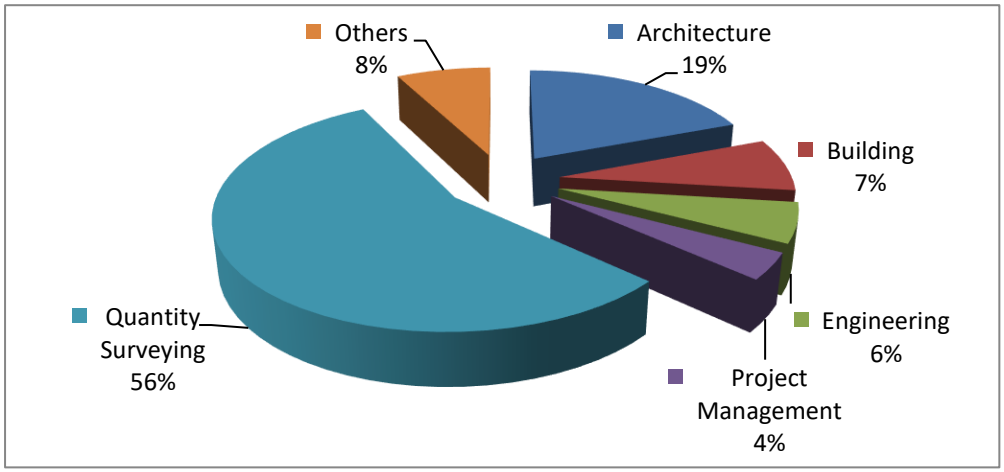

Figure 1: Respondents' professional area

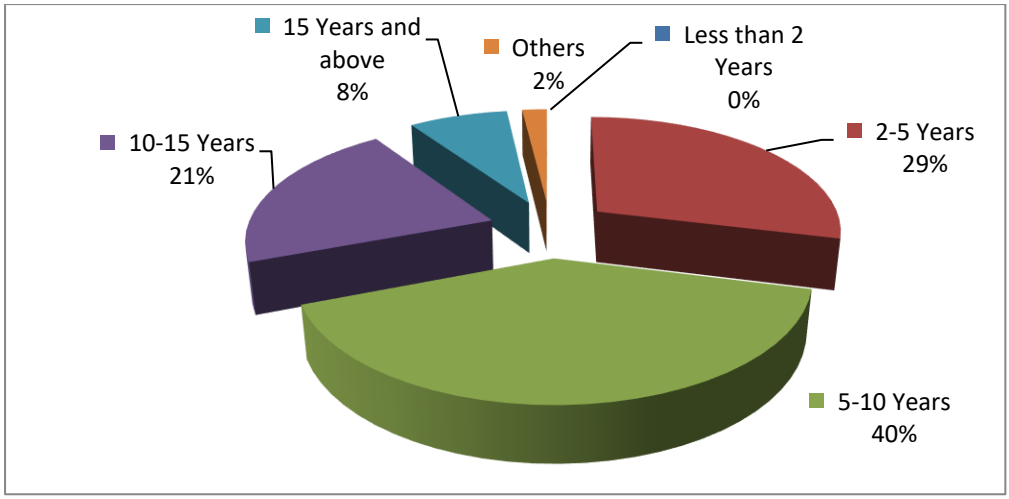

Figure 2: Respondents' years of experience

General level of BIM in the Nigeria Construction Industry

Level of BIM

The results of the analysis as presented in Table 3 revealed that within the sampled professionals in the NCI, BIM awareness and acceptance are at medium levels; this was inferred from Mean Score values of 3.10 and 2.70, which lay within the 'Medium' range (2.50 to 3.49). BIM adoption, implementation and investing in BIM are however at low levels, given observed Mean Score values ranging from 2.08 to 2.38. This implies that a lot still has to be done in the areas of awareness and acceptance, in order to improve the uptake of BIM technology. This needs to be done before efforts can be directed towards improving the adoption, implementation and investing in BIM. These results align with those of Hamma-Adama and Kouieder (2018) that very little movement in BIM matters is visible in Africa.

Table 3: Level of BIM

Level of BIM	Mean Score	SD	Rank	BIM Level
Awareness	3.10	1.52	1	Medium
Acceptance	2.70	1.52	2	Medium
Adoption	2.38	1.43	3	Low
Implementation	2.30	1.53	4	Low
Investing in BIM	2.08	1.52	5	Low

BIM software package(s) most commonly used

The use of BIM software packages was examined in this subsection. A total of seven different BIM software packages were examined in terms of frequency of use. Respondents opined that only one package, AutoCAD, was most commonly used, being subject to a 'High' frequency of use. Software packages that could be described as having a 'Medium' frequency of usage included Revit and ArchiCAD. SketchUp, another package was found to be of 'Low' frequency of use. Based on the results presented in Table 4, the most commonly used BIM software packages in the NCI, in order of use, are AutoCAD, Revit and ArchiCAD. In the UK, 41% of professionals in the construction industry use Autodesk Revit, while 14% AutoCAD (National BIM report, 2017).

Table 4: Frequency of use of BIM software packages

Revit	2.73	1.73	2	Medium
AutoCad	3.83	1.23	1	High
Sketchup	1.95	1.66	4	Low
ArchiCad	2.67	1.76	3	Medium
Bentley	0.84	1.22	8	Very low
Tekla structure	0.97	1.46	7	Very low
Navis Works	1.30	1.54	6	Very low

Knowledge of the various levels of BIM

With respect to the knowledge possessed by respondents regarding the four levels of BIM, the results obtained showed that respondents had a 'Medium' level of knowledge about BIM level 0 and BIM level 1 (see Table 5). The corresponding level of knowledge for BIM level 2 and BIM level 3 was 'Low'. This agrees with the position by Kori and Kiviniemi (2015) that the NCI is still mostly at BIM Level 1.

Table 5: Respondents' knowledge of the various levels of BIM

knowledge of BIM levels	Mean Score	SD	Rank	Remark
BIM Level 0	2.75	1.42	1	Medium
BIM Level 1	2.55	1.39	2	Medium
BIM Level 2	2.28	1.37	4	Low
BIM Level 3	2.30	1.45	3	Low

Project life cycle stage where BIM was adopted

Analysis of the research survey data revealed that BIM is mostly applied in the 'Design' stage of construction projects (Mean Score 3.50, ranked 1st), as presented in Table 6. Other project lifecycle stages that are 'Medium' users of BIM include 'Detailing' and 'Budget and estimates' (Mean Scores 3.19 and 2.88, ranked 2nd and 3rd respectively). 'Medium' use is also made of BIM during the 'Project management', 'Planning', and 'Delivery' stages of projects. However it was discovered that the 'Fabrication' stage of projects involves the least use of BIM (Mean Score 2.27, ranked 8th). This is understandable in the light of the extremely low diffusion of any technology beyond BIM Level 1. BIM technologies higher than BIM Level 1 make use of object-oriented databases, which make it possible to automate the fabrication of component parts of construction projects. This is an area in which the NCI is still lagging behind; it is in this area that countries like Finland, USA, UK, Australia, Netherlands and Singapore have experienced significant benefits in construction project delivery (Kori and Kiviniemi, 2015) through the use of BIM Level 2 and 3.

Table 6: BIM in projects life cycle

Project life cycle stage where BIM was adopted	Mean Score	SD	Rank	Remark
Planning	2.61	1.73	5	Medium
Design	3.50	1.65	1	High
Detailing	3.19	1.85	2	Medium
Fabrication	2.27	1.68	8	Low
Construction	2.59	1.81	6	Medium
Budget and estimates	2.88	1.73	3	Medium
Project management	2.67	1.74	4	Medium
Delivery	2.53	1.88	7	Medium

Impact of BIM Adoption Levels in Construction Projects

Benefits of BIM adoption on projects

Projects performance in several key performance areas was computed before and after adoption of BIM, based on questionnaire responses. The results presented in Table 7 revealed that in four out of the eight aspects of project performance that were considered, BIM adoption apparently had a noticeable impact. These four aspects were 'Greater control of the construction process' (Mean Score 2.89, ranked 1st); 'Improved collaboration between agents' (Mean Score 2.87, ranked 2nd); 'Conflict resolution and clash detection' (Mean Score 2.63, ranked 7th); and 'Reduction in labour' (Mean Score 2.47, ranked 8th). All rankings refer to post-BIM performance. These findings agree with a previous study such as Nederveen *et al* (2010) that benefits of BIM technologies include the provision of an efficient communication and data exchange system.

Table 7: Benefits of BIM Adoption on projects

Benefits of BIM adoption on projects	Pre-BIM			Post-BIM			Remark
	Mean	Rank	Level	Mean	Rank	Level	
Waste reduction	2.74	1	Medium	2.85	3	Medium	Unchanged
Reduction in labour	2.70	4	Medium	2.47	8	Low	Changed
Reduction in deviations	2.73	2	Medium	2.80	4	Medium	Unchanged
Reduction in variations/claims	2.70	3	Medium	2.67	6	Medium	Unchanged
Greater control of the construction process	2.41	6	Low	2.89	1	Medium	Changed
Improved collaboration between agents	2.24	8	Low	2.87	2	Medium	Changed
Conflict resolution and clash detection	2.30	7	Low	2.63	7	Medium	Changed
Correction and error finding	2.66	5	Medium	2.70	5	Medium	Unchanged

Bold face type indicates significant changes in element due to BIM

Building Elements that frequently enjoy BIM adoption

Respondents were asked to indicate the extent to which BIM has contributed to the improvement of the elements of their building projects. The results are presented in Table 8;

Table 8: Influence of BIM Adoption on building elements

What elements of your projects are produced in 3D digital descriptions/representations?	Mean Score	SD	Rank	Remark
None	1.68	1.87	10	Low
Walls	3.18	1.83	4	Medium
Doors	3.32	1.72	1	Medium
Windows	3.19	1.78	3	Medium
Roof	3.24	1.79	2	Medium
Electrical installation	2.50	1.66	9	Medium
Mechanical installation	2.69	1.60	5	Medium
Reinforcements	2.66	1.78	7	Medium
Plumbing	2.69	1.68	6	Medium

Eight (8) building elements were involved. The results obtained revealed that BIM adoption has had 'Medium' influence on all eight building elements, although the ranking based on Mean Scores identified the most influenced elements as Doors, Roof, Windows and Walls.

Current BIM practices in execution of projects

A total of 14 practices were ranked by respondents, and the results are presented in Table 9. Only one (1) practice was ranked as occurring to a 'High' extent; this was 'CAD files (2D and 3D) are primarily used' (Mean Score 3.69, ranked 1st). Ten (10) other practices were carried out to a 'Medium' extent. The three least occurring practices which were only carried out to a 'Low' extent and were ranked 12th, 13th and 14th were 'File synchronisation at specific intervals carried out on projects'; Collisions effectively eliminated in the design phase and no clashes on the site'; and 'Collision detection by any BIM software'. This shows that project sites in Nigeria are yet to enjoy the full benefits of BIM which include clash detection and cost reduction (Eastman *et al*, 2011).

Table 9: Current BIM practices in execution of projects

What are the current practices in the execution of your projects?	Mean Score	SD	Rank	Remark
Traditional design methods	2.53	1.52	9	Medium
CAD files (2D and 3D) are primarily used	3.69	1.44	1	High
Construction site is provided with the traditional paper version of the documentation	3.33	1.52	2	Medium
Data coordination are conducted on BIM	2.82	1.55	4	Medium
CAE files BIM browsers are used, e.g. Autodesk *Navisworks*	2.71	1.33	6	Medium
Collision detection by any BIM software	2.27	1.50	14	Low
Projects have a central file on company's server with local files on PC's	2.50	1.72	11	Medium
File synchronisation at specific intervals carried out on projects	2.38	1.50	12	Low
Construction sites are provided with the traditional paper version of all documentation as well as with the BIM model	2.82	1.67	3	Medium
Collisions effectively eliminated in design phase and no clashes on site	2.38	1.48	13	Low
During design, fewer redesigns, revisions and changes	2.81	1.53	5	Medium
Accurate ordering of materials and elements	2.70	1.62	7	Medium
Quantity of materials consistent throughout the project duration	2.67	1.54	8	Medium
No unnecessary or incompatible elements	2.53	1.52	10	Medium

Bold face type indicates significant MS values

CONCLUSION

The paper assessed the adoption of Building Information Modelling (BIM) in the Nigerian Construction Industry (NCI). It has revealed that in the NCI both awareness and acceptance of BIM can be described to be in 'medium level' of knowledge within the range of BIM level 0 and BIM level 1. BIM software usage is dominated by 'AutoCAD' package and the most common BIM practice is distribution of contract or production information 'via paper or electronic form e.g. PDF', which is indicative of BIM Level 1. The paper has found that BIM adoption had a noticeable impact in four project performance aspects; use of BIM resulted in 'Greater control', 'Improved collaboration', 'Conflict resolution', and 'Reduction in labour'. The adoption of BIM has had a 'Medium' impact on no less than eight building elements. Based on the foregoing findings, it was concluded that BIM use in the NCI is still at a rudimentary level, but great potential for improvement exists, if the right environment (political, legislative, contractual, technical) is provided.

This paper recommended that the Federal and State governments should devise an Implementation Strategy Plan for BIM that will (i) explore how to make the use of BIM mandatory for all projects, (ii) support the use of BIM through incentives and (iii) fund BIM research and development (R&D). In addition, to increase BIM penetration among firms,

Clients might offer some form of subsidies for BIM costs which could be included as items in the Preliminaries of construction contracts. It needs to be stated that these results have been obtained from analysis of a very limited sample of construction professionals. Further research could focus on validating these results through the testing of a larger sample of construction professionals.

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Land Use Changing Pattern and Urban Growth Felele Area, Lokoja Nigeria

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Abstract:

Urban ecological systems are characterized by complex interactions among institutional, socio-economic and environmental variables. These interactions generate complex human-dominated landscapes, which significantly influence effective functioning of local and global earth ecosystems and the services they provide to humans and other life on earth. Changes in ecological conditions that result from human actions in urban areas ultimately affect physical morphology and structural outlook. Using Survey Research Design (SRD) via questionnaire administration, observation with site photographs and personal interview for data collection, authors investigate the impact of urban growth on the environment as occasioned by the existence of a polytechnic essentially, the effects that the growth has on the ecological system of the Felele community. Findings in the study revealed that urban development affects the spatial heterogeneity of the landscape; especially the patterns of variation in land cover and changes in land use over time. The authors propose that effective monitoring agent to guide the direction and coherence of development in the study area is needed to forestall the haphazard pattern of development that is rampart in the area. Also, essential services like power supply and water supply in the area need urgent attention so as to facilitate adequate and regular supply in the area.

Keywords: Urban Growth, Land-Use, Pattern, Changing, Lokoja.

Introduction

Change of use as a concept tiptoed into development control arena by the fact that it is now regarded as development following an official endorsement or approval of the relevant development control department for any land development (Hald, 2009). But the cogent question still remains what constitutes change of use? From broad perspective the construction of a new building can be said to be a change in use of the land because the building is for a purpose which is different from the purpose for which the land was last used. Land use changes are common phenomenon in city development process, which can happen within and or outside the city. Most often, residential areas are susceptible to land use changes due to characteristic of the neighborhoods, accessibility, renting/business factors and government policy (Yuri, 2009).

Change in economy and spatial distribution of population can occur through conversion from one land use to another. For instance, converting farm lands into residential, industrial, Commercial or recreational use or vice versa. The land owners play key role in whatever will take place on his land and, therefore, their decisions identify the direction and quantity of changes (Ettema *et al*, 2010). Consequently, different land owners decide in different ways according to land types and parameters. The owners have to supply the financial investment of land change; thus, their awareness of the economic situation controls the speed of the changes and the final decision to be taken. In other words, the landowner may decide to leave the land at its current circumstances, develop the land by changing the land usage and exploit it, develop the land by changing the land usage and sell it or dispose it. The options vary with the preferences of different land owners. For instance, a farmer is not able to develop his land into a residential area if he does not have the required investment power and skills.

Ettema, *et al* (2010) differentiates between three different types of land owners according to their preferences. For example, farmers' preference is to exploit, sell or buy lands. Government's interest, on its own, is to maintain and sell or to develop and maintain while developer's preference is to develop and sell or redevelop and exploit or sell. The eventual decision will depend on the expected value of each option to the owner. In case of commercial owners, utility will match with profitability; action will be taken on whichever delivers the highest profit. In case of government, social benefits might play a significant role whereas to the farmers, personal and emotional interest may influence their decision. The market price is a valuable index in deciding whether or not to sell a land with or without developing it (Ettema *et al*, 2010; Koomen *et al*, 2010).

The tendency of any change in land use began as penetration process of commercial activities, which then continue to increase and dominate within an area. The occurrence of land use changes brings out questions on how the change took place and what are strong factors that cause them to happen. To answer the questions, it is important to analyze the structure and pattern of the changes and the causative factors. In this study, however, there is one special characteristic of the changes where most of the actors are academicians of who majority are students' tenants with few staffs of the institution living among the host community. This seems to be a motivating factor that speeds up the rate of development and changing land use pattern around the polytechnic community. The thrust of this paper is unguided rapid development around the Kogi State Polytechnic (KOGIPOLY), Lokoja with a view to examine planning implication on the environment.

Institutions can be valuable contributors to city's economy. They are immobile institutions fairly resistant to business cycle fluctuations. They tend to attract revenue from outside the immediate quarter through tuition, endowment income or state tax allocations which attract significant human capital, both students and employees from national market that contribute to the development in area of economic growth. The increase in population of student admitted every year since inception of the state polytechnic up till date keep increasing as well as the demands in various ways. There are great needs of accommodation hostels and business centers where to photocopy reading materials and print assignments, market where to buy food stuffs, beverages, banks for money transactions etc. All these are essential needs to be met in the institution environment and the services require spaces for all their activities.

Issues and Literature:

Urbanization is an inevitable process that goes along with economic development and rapid population growth. The expansion of residential and commercial land uses into rural areas at the periphery of metropolitan areas is considered to be a sign of regional economic liveliness whose benefits are increasingly unbiased against ecosystem impacts (Rimal, 2011). This includes degradation of air and water quality, loss of farmlands and forests, social fragmentation and infrastructure outlay (Squires, 2002; Yuan et al, 2005; Rimal, 2005 and 2011). It is generally believed that urbanization has both direct and indirect impacts on land use transformation such as urban sprawl and urban degradation. Urban areas and their urban-rural linkages are characterized by high dynamics of human influence and the associated land use patterns. In order to effectively address the issue of land use change process, a well-founded knowledge of underlying causes and driving factors is needed (Rimal, 2011). Spatially explicit land use modeling techniques have successfully been applied to sculpt the present and likely

future land use patterns of urban areas (Lakes and Lautenbach, 2008). The report of World Urbanization Prospect (2009) showed that Northern America, Latin America and the Caribbean, Europe and Oceania are highly urbanized with proportion urban ranging from 70.0% in Oceania to 82.0% in Northern America. The level urbanization is expected to continue rising to about 84.0% in all these areas by 2050. In contrast, Africa and Asia remain mostly rural, with just 40.0% and 42.0% of their respective population living in urban settlements in 2010; and even by 2050, they are expected to be significantly less urbanized than the other major areas, reaching a proportion urban of 62.0% in Africa and 65.0% in Asia (United Nations, 2009).

Land Use Changes: according to Environmental Literacy Council (2002), is used to describe the various ways in which land and its resources are been utilized by different people, such as farming, mining, building and grazing. Choices of how land is being used are made by those who own or control the land. But the choices are limited by the physical and biological characteristics of the land, which include the climate, soil and topography as well as institutional and economic factors. Urban land uses are classified into different parts such as residential, commercial, industrial, institutional, public, open space, infrastructural, and mixed land uses. *Land Cover*, on the other hands, refers to the physical and biological cover over the surface of land which includes water, vegetation, bare soil, and/or artificial structures.

Land use is a more complicated term which is defined by the natural scientists in terms of syndromes of human activities such as agriculture, forestry and building construction that alter land surface processes including biogeochemistry, hydrology and biodiversity (Adebayo, 2010; Ellis, 2010). Changes in land use and land cover date to pre-historical milieu have both direct and indirect consequences of human actions to secure essential resources. This may first have occurred with the burning of areas to enhance the availability of wild game and accelerated dramatically with the birth of agriculture, resulting in the extensive clearing (deforestation) and management of earth's terrestrial surface that continues till date. More recently, industrialization has encouraged the concentration of human populations within urban areas (urbanization) and the depopulation of rural areas accompanied by the intensification of agriculture in the most productive lands and the abandonment of marginal lands. According to Ellis (2012), all of these causes and their consequences are observable simultaneously around the world with its attendant consequences in form of biodiversity loss, climate change and population growth.

Rapid growth of cities in most African countries is traceable to rural-urban migration. It appears that large number of migrants to cities originates from smaller urban centers, and particularly from rural areas, leading to urban expansion. Consequently, Udo (1987), Oyinloye (2010), Ellis (2012) and Owoeye (2013) observed some factors that encourage physical expansion of urban centers to include natural population increase, job-creating investment, industrial development, infrastructural development, housing provision and quality as well as level of commercial activities in cities.

Conceptual Framework of Land Use

The term «land use» has found its way into the language not only of geography, but also of other disciplines; economics, sociology public administration and law, engineering, and planning. Planners accused of being jacks of all trades and thoroughly trained in none, when

driven to the wall to define their special field of competence, tend to fall back on land use planning. Certainly, land use is an important concept not only for description and analysis, but also for prescription and planning. Thus a discussion of various concepts involved in the precise meaning of the term land use is of considerable relevance to those who use it. At first glance land use appears to be a simple and unequivocal concept. If I am not mistaken, it originated in relation to agriculture. Farm land may be used for growing wheat, or corn, or for grazing cattle. That is simple enough. Here, the emphasis is on the use of the land, of its productive capacity. What happens on the land depends on what is taken from the land.

In an urban environment, the area with which I am familiar and to which I will limit my remarks - the emphasis shifts to use on the land. Certainly, physical characteristics such as slope, drainage, bearing capacity, climatic and scenic conditions play a role in determining urban land use, but their importance is secondary to the relation of a piece of land to human activities located on other pieces of land. For urban use land is a site, rather than a factor of production. The attempt to analyze or classify his blandly defined concept, but proceeds to divide developed land into two groups of sub-categories, those «privately» and those «publicly» developed. This division reflects the dependence of land use concepts on the practice of zoning, which on the continent has preceded and, for a long time, has dominated planning. Zoning, originally and essentially not a device for community planning, but for property protection, restricts the use of parcels of privately owned land in the interest of the owners of neighboring parcels; it does not cover land which is publicly owned and developed.

Thus, while the first division establishes its categories according to the criterion of purpose - «developed» or «vacant» for urban purposes the second one introduces a completely different criterion - ownership. Other criteria appear in the third step, the division into sub-categories. «Privately developed» land is divided into six sub-categories: single, two and multi-family residential, commercial, and light and heavy industry. The terms residential, commercial and industrial denote the purpose or function of a piece of land. But the difference of the three residential categories refers not to different functions, but to different types of structure (Sindhakara, 2012).

Methods and Materials

Study Area

Kogi State Polytechnic, Lokoja is located within the neighborhoods of Felele. It is about 4 kilometers away from Lokoja metropolis but less than a kilometer to Felele thereby making it the closest community. Felele is strategically located and very accessible to other neighboring towns within the axis. For instance; Kabba junction and Zaraggi are located to the east, Galili and Kabawa to the west, Natacco to the north and Lokoja metropolis (the state capital) is about 4 kilometers to the south. The land area is relatively hilly with lush grassy vegetation and sparse forested area. While heading towards zango and Banda, the land is thickly forested and mountainous which wall up the community on both sides. The residence of Felele can be classified into four categories - the artisans, farmers, civil servants and students, essentially the students of the polytechnic. Before the inception of the polytechnic, the people in the community were mainly farmers and into other related jobs. As the community continues to witness growth in terms of infrastructure and socio-economic development, their daily jobs become diversified. Lots of commercial activities, small scale industries, transport ventures

and several government establishments begin to spring up with ample job opportunities for the residents, both skilled and unskilled.

The polytechnic was founded in 1993 but did not commence academic activities until 1995. Since then, it has gone through a lot of transformations and changes in terms of the staffing, students' population, incorporation of new field of disciplines and establishment of skill acquisition centers. Different governments at certain period of time have influenced the polytechnic since its inception till date. On physical structure, the polytechnic has made tremendous impact on the environment though her various contributions, particularly in the area of population increase. It serves as growth center which attracts influx of people from different part of the state as well as other parts of the country. The institution has also influenced the daily activities of the host community, i.e. Felele, from a mono (agrarian) activity to more diversified activities. Nonetheless, the developments come with penalties which include irregular urban structures, derelict/substandard dwellings, houses and structures put up in haste to serve the pressing demands of students, agricultural lands been converted to residential and commercial land uses thereby forcing farmers, laborers and people in the community to hunt for white collar jobs. This change in use brought about by the location of the tertiary institution requires an in-depth understanding to ameliorate the possible negative impacts of the perceived irregularities in the urban structural arrangement of the community and as well give meaning to the land use for a harmonious environmental management.

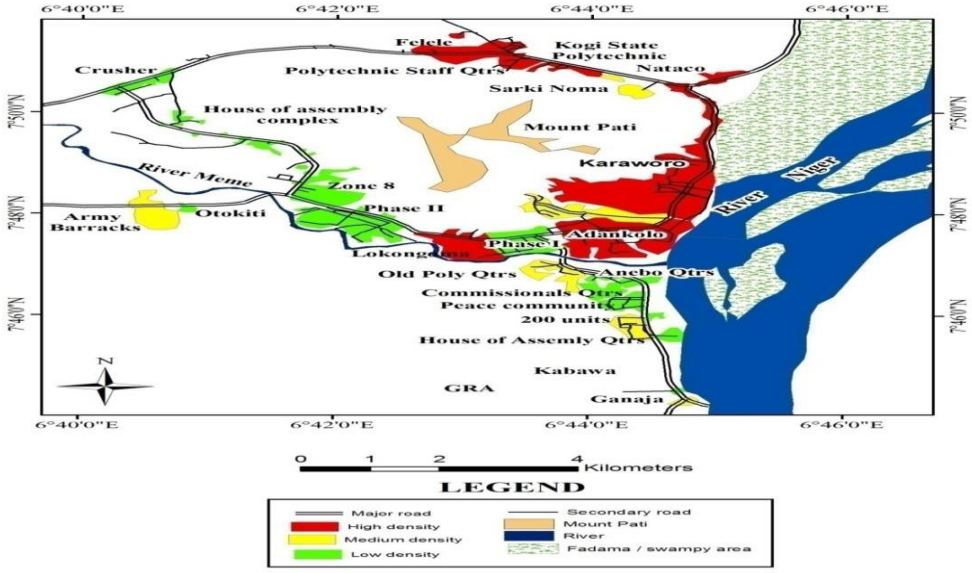

Figure 1: Lokoja Built up Areas,

Source: Adapted from Adetunji (2017)

Methods of Data Collection and Sources:

Data collection for this study was essentially through *Survey Research Design (SRD)* with the aid of personal interviews, structured questionnaires, photo-snaps and observation. Other sources include government ministries and establishments, journals, textbooks and internet facilities. For the purpose of this study, a percentage representation method was adopted to obtain a quota sample of residents around the polytechnic environment. The residents were categorized into three zones following the developmental levels in the study area. This involves

the *core* and the *peripheral* area of Felele community towards the polytechnic site and the *immediate surroundings* of the polytechnic area. Thus, the residents of houses in these three zones become the target population for the study. In all, there are 1354 buildings out of which 203 were randomly selected for questionnaire administration using systematic random sampling technique at every 5th buildings on household basis interval. This represents 15.0% of the building population in the study area. Owing to invalidation of 3 out of the total questionnaires administered due to observed inconsistencies, 200 (representing 98.50% of the 203 questionnaires administered) were analyzed using both descriptive and inferential statistics.

Findings and Discussion:

Socio-Economic Characteristics of Respondents.

As shown on Table 1, majority (40.0%) of the sampled respondents were within the age bracket of 18–35 years out of which 22.5% were students of the polytechnic, followed by those within 26-35 years (25.5%). Respondents above these ages (i.e. 36 years and above) who are either staff members of the polytechnic, landlords or other residents of houses in the study area, altogether were about 34.5% of the sampled respondents.

Table 1: Socio-economic Characteristics of Respondents

Variables	Frequency	Percentage
Age Distribution		
18 - 35 years	80	40.0
26 - 35 years	52	25.5
36 – 45 years	21	10.5
46 – 55 years	5	2.5
Above 56 years	43	21.5
Total	**200**	**100.0**
Gender Distribution		
Male	112	56.0
Female	88	44.0
Total	**200**	**100.0**
Period of Residency		
Less than 5 years	105	52.5
5 - 10 years	27	13.5
11 – 15 years	38	19.0
16 – 20 years	14	7.0
21 – 25 years	7	3.5
Above 25 years	9	4.5
Total	**200**	**100.0**
Occupational Distribution		
Artisan	52	26.0
Trading	41	20.5
Professional	44	22.0
Students	45	22.5
Public Servants	18	9.0
Total	**200**	**100.0**

***Source**: Authors' Field Survey, 2019*

The period of residency in the area was investigated to ascertain relevance and genuineness of information given by the respondents. Majority (52.5%) live in the area in less than 5 years who were mainly students of the university while those with higher period of tenancy were

mainly native of the community. This information gives a fair representation of the target population for the study.

Neighborhood Infrastructure and Building Characteristics

Table 2 shows the characteristics of buildings in the study area and the condition of neighborhood infrastructures. As shown on the table, majority of the buildings are Brazilian types. This accounts for about 52.0% of the buildings in the area which are very common in the core of the community. Blocks of flats and bungalows are building types that are common around the polytechnic which are mostly occupied by the staffs and some students of the polytechnic. Larger percentage of these buildings is newly built which are in good conditions. Over 50% were built in less than 10 years, usually within the vicinity of the polytechnic. Only about 22.5% were built above 40 years which are buildings at the core area, some of which are in bad conditions.

Considering the uses of buildings, over 60% are used for residential purpose followed by commercial uses (17.5%), mixed uses (9.0%) and religious uses (8.5%). As usual, about 66.5% of these buildings are connected with Power Holding Company of Nigeria (PHCN) for source of power generation.

The level of adequacy and regularity of PHCN source of power supply was investigated. Over 60% are of the opinion that the power supply through PHCN is fair, poor or very poor which shows the level of problem the residents (including students) faced regarding electricity supply in the area. This is the reason why 27.5% and 6.0% make use of generating set and inverter as supplement respectively.

Level of Development and Changing Land Use Pattern

Land use change is the alteration in the initial use to which a piece of land is subjected to; one of the end results of urban development. Plate 1 depicts the common occurrence in newly open up sites of the community, portraying the evasive characteristics of residential land use in the polytechnic environment, as the demands for housing units by individuals and cooperate bodies increases. This infringes on farm lands and consequently has effects on the evolvement and pattern of land use in the area.

Investigation into major reasons for the changes in land uses in the study area, about 50% was of the opinion that the latter uses, which majority are either residential or commercial use, have high economic benefit to the owners and the community at large than the initial uses. About 27.5% agreed that the change in land use in the area is resultant effects of development trend emanated from the location of the university while 12.5% are of the opinion that it is as a result of availability of affordable lands in the area. The remaining 10% posit the proximity to student area. This result is illustrated in Figure 2. The general observation made on urban development trends in the area focuses on high demands for land and increase in development of residential buildings, leading to congestion in the university environment.

Table 2: Neighborhood Infrastructure and Building Characteristics.

Variables	Frequency	Percentage

Building Types				
Brazilian Style		104		52.0
Blocks of Flats	66		33.0	
Bungalows		21		10.5
Story Buildings	9		4.5	
Total		**200**		**100.0**
Age of Buildings				
Less than 10 years		102		51.0
10 – 20 years		17		8.5
21 – 30 years		15		7.5
31 – 40 years		21		10.5
Above 40 years	45		22.5	
Total		**200**		**100.0**
Uses of Buildings				
Residential		131		65.5
Commercial		35		17.5
Religious		16		8.5
Mixed-use		18		9.0
Total		**200**		**100.0**
Sources of Power Generation				
PHCN		133		66.5
Power Generating Set		55		27.5
Inverter	12		6.0	
Total		**200**		**100.0**
Adequacy of Power Supply				
Very Good		2		1.0
Good		61		30.5
Fair		48		24.0
Poor		48		24.0
Very Poor		41		20.5
Total		**200**		**100.0**

Source: *Authors' Field Survey, 2019*

Hence, the need for adequate measure to mitigate the trend to forestall any environmental degradation and its attendant consequences in the area become pertinent.

Plate 1: Farmlands being cleared and prepared for building construction around the study area

Source: Authors' Field Survey, 2019.

The level of development regarding building materials used for construction was examined. Figure 3 shows major materials used. Arising from the investigation, larger percentage (64%) make use of cement blocks being modern buildings found around the polytechnic environment which occupants are mostly the polytechnic students. The 31.5% of the sampled buildings constructed with mud blocks are those at the core of the community and probably nearby huts at the peripheries occupied by the 'Oworo' (people who mostly specialized in farm work. See examples in Plate 2). The 4.5% are those constructed with planks and bamboo which are mostly used as temporary sheds for road workers. Buildings found in these areas are generally substandard for human habitation.

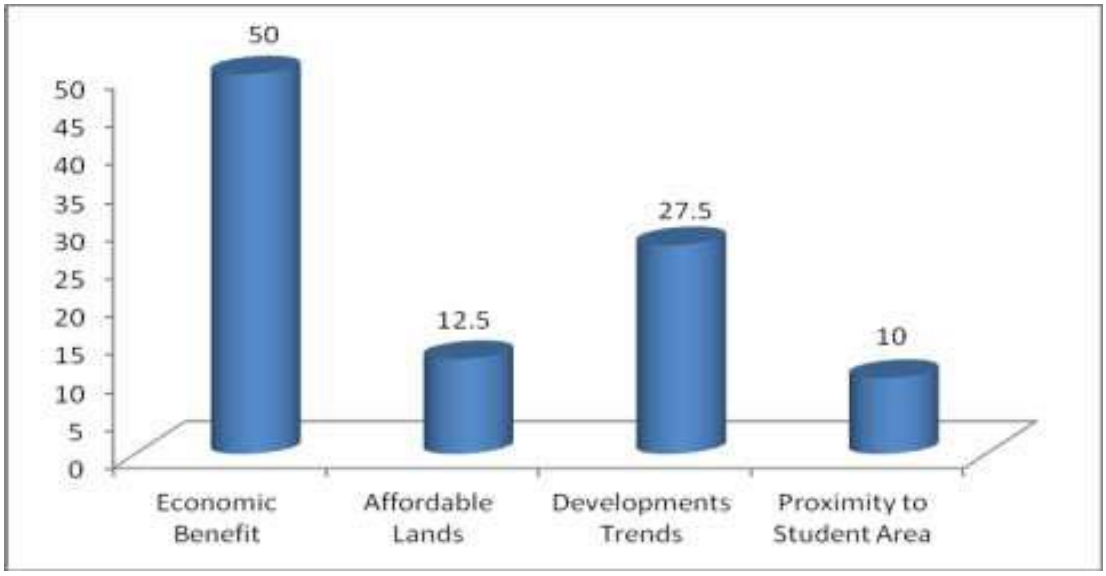

Figure 2: Reasons for Changing Land Use Pattern in the Study Area

Source: Authors' Field Survey, 2019

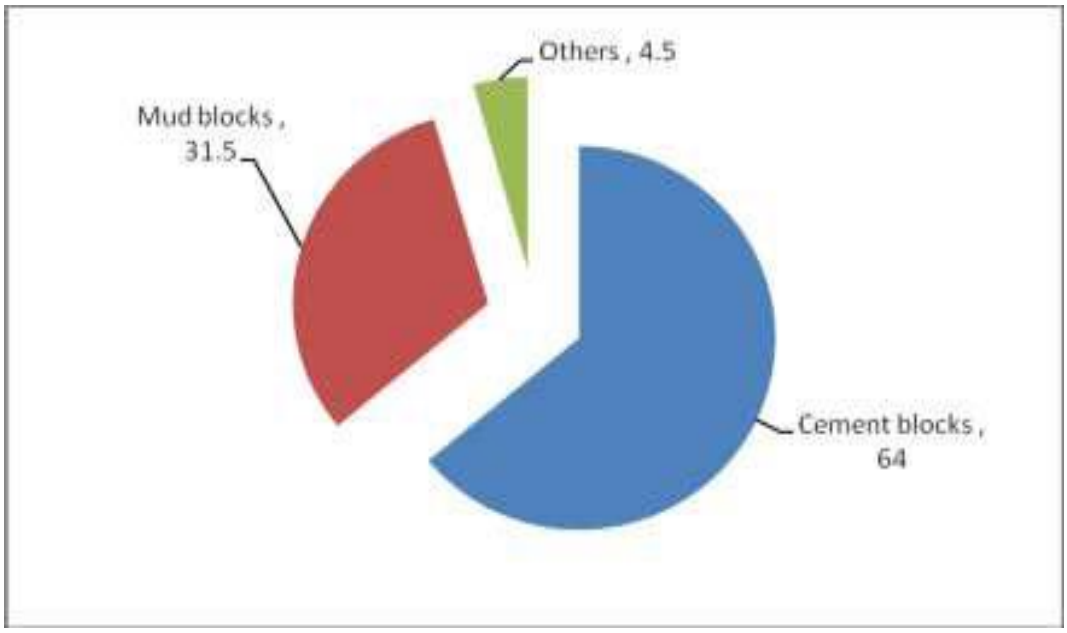

Figure 3: Material Used for Building Construction in the Study Area

***Sourc**e: Authors' Field Survey, 2019*

Plate 2: Building Types at Oworo Community and at the Periphery of Felele Town

***Source**: Authors' Field Work, 2019*

Recommendations and Policy Implication:

This study provides insight to urban development and land use changes as determined by individual property owners at certain time or the other depending on the developmental and socio-economic trend at a point in time which influences the pattern and direction of the development in the area. One of the major findings was that the immediate environment of the polytechnic campus is the most developed area, living the rest of the study area (i.e.Felele community) with a minimal but yet tangible effects of the presence of the polytechnic. Secondly, there are lots of higher order services still not available at the community despite the presence of the polytechnic. For instance, the facilities available in the medical center in the community are owned by the state government (i.e. Felele community health center). Looking at the level of facilities, they cannot handle major medical cases. Thus, patients are forced to go to either the Federal Medical Center, Lokoja or visits the State Specialist Hospital, Lokoja; a far distance town from the study area. Prominent among the findings is the erratic nature of power supply in the area which needs government attention due to high population of students.

Based on major findings in the study, the following recommendations are put forward as policy guidelines toward a sustainable urban land use management in the study area. There should be in place a monitoring agent to guide the direction and coherence of development in the study area. This will forestall the haphazard pattern of development that is rampart in the area. Aside, there should be tremendous investment to provide adequate funds in building of resourceful environment focusing on standard housing units to enhance productivity of residents. Higher

order services should be made available in the community to check incessant trips made to the state capital by all the residents of the community. The medical facilities in the environment should be upgraded to handle emergency medical cases rather than sending all complex cases to FMC and SPECIALIST HOSPITAL. Besides, essential services like power supply in the area need urgent attention. Government should provide transformer to facilitate adequate electricity supply that will curb erratic nature of power supply in the area.

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SUB-THEME 3:
SUSTAINABLE BUILDING MATERIALS

Sustainable Building Material for Green Building Construction and Conservation

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Abstract

Materials are the building's essential components. The building structural capacity is accountable for chemical, physical and mechanical properties of materials as well as an acceptable model. Therefore, green building design will start with the choice and use of environmentally friendly materials with similar or better features than conventional building materials. Construction materials are typically chosen by practical, technological and financial requirements. Nonetheless, with sustainability as a crucial issue in recent decades, the construction sector, directly or indirectly causing a significant portion of the annual environmental degradation, should assume the duty to contribute to sustainable development by seeking more environmentally friendly building and design methods. Among the approaches in new material uses, recycling and reuse, sustainable product development or green resource usage, careful selection of environmentally friendly sustainable building materials can be the fastest way for developers to start incorporating sustainable design concepts into buildings. Globally, the research community has undertaken significant efforts to explore alternative sustainable building materials and low-tech technologies, resulting in a more sustainable and accessible construction that meets today's comfort requirements. To achieve this goal, adopting green building materials is a good alternative. Therefore, in a nation's sustainable development, choice of building materials with minimal environmental burdens is useful. This paper reviews research works with the aim of illustrating how sustainable building material can help reduce the impact of environmental degradation and create healthy buildings that can be sustainable for both the occupant and our climate

***Keywords*:** Sustainable Building, Sustainable Materials, Green Building, Construction Industry.

INTRODUCTON

Buildings have a huge impact on the environment, using about 40% of natural resources produced in developed nations (Pulselli *et al*., 2007), using almost 70% of energy and 12% of drinking water (Weng *et al*., 2005), and generating about 45% and 65% of the waste disposed of in our landfills (Yudelson, 2008). In addition, they are responsible for a massive amount of harmful emissions due to their activity, accounting for 30% of greenhouse gases, and an additional 18% indirectly caused by product production and transport (Venkatarama *et al*., 2003). At the same time, the poor quality of indoor environments can lead to health problems in office buildings for workers, thereby reducing efficiency (Ries *et al.*, 2006). Building also uses 40% of the world's raw soil, gravel and sand and 25% of the raw timber. From the perspective of the environmental impact, the construction sector has a huge impact on the environment as a whole (Yu C, 2008). Residential buildings represent a large percentage of the built environment, and for general sustainability it is important to choose materials and designs.

The research community around the world has taken significant steps to find alternative sustainable building materials and low-tech approaches, resulting in a more efficient and affordable construction that adheres to today's comfort standards. Adopting green building materials is a perfect way to achieve this aim. In a country's sustainable development, choice of building materials with minimum environmental burdens is useful. Creating a relevant commitment to environmental issues is therefore necessary and therefore key. The choice of environmentally preferable building products is an ideal way to boost the environmental quality of a house.

While there is clearly an urgent need for new technologies to maximize the use of low-impact building materials, it is also true that several technologies or systems are in use at the moment (Fernandez *et al*., 2006). Many have come from an earlier surge of sustainable housing activism and growth, sparked by the environmental movement of the 1970s (Copper *et al*., 2009) and then boosted by the energy-efficient building force [10]. their strategy has been referred to as effective in spreading ideas about best practice to dedicated green advocates, builders and individuals seeking for an alternative means of determining the material-selection process, very few such systems are available that support the effective and substantial use of local and recycled building materials in the design-decision making phase of a building (Fernandez *et al.*, 2006).

The study's aim is to discuss and illustrate how sustainable building material can help reduce the impact of environmental degradation and create healthy buildings that can be sustainable for both the occupant and our natural environment.

DEVELOPMENT OF GREEN BUILDING

To mitigate the effects of buildings over their life cycle, Green Building (GB) has become a new philosophy of building, advocating for more environmentally friendly materials, introducing resource-saving techniques and lower waste use, and enhancing indoor environmental quality, among others (Thormark *et al.*, 2006). This could result in ecological, political, economic and social advantages. For example, cost savings in operation and maintenance in GBs can be achieved through the installation of high-efficiency lighting and insulation systems (Ross *et al.*, 2006) or through an effective product selection process that takes into account, for example, the reflection of the daylight roof (Edwards *et al.*, 2003). Certain primary benefits of GBs related to improvements in indoor environmental quality are decreasing health costs and increasing the efficiency of employees (Thormark *et al.*, 2006) through their perceived satisfaction with work areas (Ries *et al.*, 2006). In addition, intangible benefits, such as the reputation of the building and contractor, and perceived added value must also be recognized (Muse *et al.*, 2006) simply because they can direct shareholders ' and potential owners ' decisions (Baker *et al*., 2006). Despite their proven advantages, GBs are not yet considered desirable projects as most developers link green features to cost-effective technologies (e.g. photovoltaic panels, grey water reuse systems) [Sherwin *et al.*, 2006]. Nonetheless, a thorough design process and a systematic method of product selection may be adequate to achieve ideal environmental targets at a lower cost, rather than a high investment in engineering. In addition, some research supports the insufficient gap between some GBs ' average investment cost per square foot, such as academic buildings, labs, community centers and outpatient care facilities, and that of non-green buildings with the same characteristics (Mattiessen, 2008). In addition, GBs have better long-term dividends (Kats *et al.*, 2003) retaining up to 10 times the green premium by rendering expected benefits (Kats *et al.*, 2003). The achievements of a GB will depend on the quality and effectiveness of the installed green systems. Therefore, the market demands a specific approach to differentiate GBs from conventional buildings through the use of standard, transparent, objective, and verifiable measures of green. That will ensure that the minimum green standards have been achieved.

A. Building materials problem

With homes, the product problem typically takes different forms. As stated, it is necessary to consider the grey energy and pollution, and the development of building materials requires the use of higher value energy and resources compared to building operations. There are also environmental issues with the by-products of material used in buildings, and there are

limitations on the extraction of resources used in numerous building ingredients. In addition, the technology used to sustain the built environment should be considered.

There are many technological advances that need to be made to tackle the complications related to building materials due to resource depletion, oxidation, emissions, reliability, lifespan, etc. Second, new construction needs to be built more sustainably so that it not only eliminates the negative aspects of construction and operations, but also mainly increases the lifetime of the building, which can be achieved by removing design features that are easily obsolete. All relevant factors should also be planned for recycling or raw material recovery with limited lifespan. In all respects, this must be done by deliberately breaking down the complexities of the building into its components and recognizing practically all trade-offs between interconnected systems in order to achieve a truly sustainable solution. This can be improved by an understanding of the rapidly growing variety of readily available materials for the construction of buildings, enclosures and systems.

Ultimately, with regard to the end of a building's life, consideration for the handling of the materials must be extremely careful. This should be addressed in advance during any building's design stage, where composites that are difficult to handle are reduced. Products that can be used directly without the need to reuse them should be used. They can be recycled as raw materials if they cannot be reused immediately. These should be used at the same level of quality if they should be recycled, thereby eradicating any down cycling or waste.

B. Material selection

The use of durable, attractive and environmentally responsible building materials is a key component of any high-performance construction project. The use of natural and healthy products leads to the inhabitants ' well-being and a sense of connection with the natural world's abundance. Most building materials have significant environmental impacts from the release of chemicals, habitat destruction, and natural resource depletion. This will occur during raw material processing and storage, development and manufacturing processes, as well as transportation. Furthermore, certain building materials can affect human health by exposing staff to harmful and dangerous chemicals and building occupants. Consequently, the identification and procurement of environmentally preferable materials for use in pre-building construction activities presents an opportunity to minimize these impacts on the environment and human health. Generally, choosing environmentally friendly products with reduced environmental impacts is accomplished by resource management and non-toxic product selection processes.

Through depleting natural resources, consuming electricity, and introducing toxins into the soil, water, and air, the products used to produce building materials affect the environment. Products that contain unpleasant, odorous, dangerous or poisonous elements adversely affect overall human health by volatile or direct contact gassing. Preferably, choices of products can be made on the basis of a comprehensive environmental burden analysis throughout the product or service as a whole.

This method, referred to as an environmental lifecycle assessment, is rarely feasible for most construction procurement decisions. Nevertheless, lifecycle analysis can be extended to assess what is known about the product's environmental quality and make wise choices.

SUSTAINABLE BUILDING MATERIALS LIFE CYCLES

Evaluation of construction items, from the selection of raw materials to their final disposal, gives a better understanding of the materials ' long-term costs. Not only the consumer, but also

the owner, the tenants, and the community bear these costs. Life Cycle Design principles provide important guidelines for building material choice. For its environmental impact, each step of the manufacturing process, from sourcing raw materials, processing, delivery and installation to ultimate recycling or disposal is inspected. The life cycle of a product could be well divided into three stages: pre-building, construction, and post-building (Jong et al., 2003). These steps are similar to the building's own life cycle phases. The estimation of the environmental impact of building materials at each point allows for a cost-benefit analysis over a building's lifespan, rather than just an accounting of the initial construction costs.

A. Pre-Building phase

The Pre-Building Phase explains how a product is manufactured and shipped up to the point of construction, but not included. It consists of discovering raw materials in nature as well as collecting, processing, packing and transporting them to a construction site. This specific stage has the greatest potential to create destruction of the environment. Knowing the environmental impacts during the pre-building phase will result in a wise selection of materials for construction. Techniques of sourcing of raw materials, the production process itself, and the distance from the production site to the construction site all have environmental consequences. An awareness of the beginning of building materials is crucial for an understanding of their collective environmental impact when defined in a building type (Jong et al., 2003)

B. Building phase

The Construction Period applies to the useful life of a building material. This phase starts at the point of integration of the material into a frame, includes the maintenance and repair of the material, and continues on in or as part of the building throughout the lifespan of the material. There may be considerable material waste produced on a building site. At this point of the construction life cycle, the choice of building materials with regard to reduced building waste and waste that can be recycled is critical. Long-term exposure to specific building materials can be harmful to the overall health of occupants of a house.

Despite increasing understanding of environmental health issues regarding exposure to a number of products, in fact schools have little emphasis on choosing materials based on their potential to gas harmful chemicals, require regular maintenance with such chemicals, or require regular replacements that prolong the process of exposure.

C. Post-Building phase

The Post-Building Phase applies to building materials when they have run out of value in a construction. A product might be recycled in its entirety at this point, have its elements incorporated back into other products, or maybe thrown away. From the designer's perspective, the minimum calculated and least recognized stage of the life-cycle of the building may occur when the useful life of the building or product is exhausted. Building demolition and removal of the resulting waste has a significant environmental expense. Degradable materials, alone or even in combination with many other materials, can produce harmful waste. Gradually insufficient landfill space is filled by toxic materials. A present structure's proactive reuse reflects the resources that went into its materials and building. If these tools are not used properly, the energy invested in the construction of the building alone and the processing of these materials will be lost.

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COMPONENTS OF SUSTAINABLE BUILDING MATERIALS

Generally, when assessing related materials or materials selected for similar function, cost has long been the primary consideration. Furthermore, in keeping with the material life cycle, experts selected three types of requirements that can be used to consider the environmental sustainability of building materials. The presence of one or two of these elements in building materials makes it safe for the environment. Some of the widely known components of sustainable construction material are listed in Table 1 below:

Table 1: Component of Sustainable Green Materials

Component of Sustainable Green Materials		
Manufacturing Process (MP)	Building Operations (BO)	Waste Mgmt. (WM)
Waste Reduction (WR) Pollution Prevention (P2) Recycled (RC) Embodies Energy Reduction (EER) Natural Materials (NM)	Energy Efficiency (EE) Water Treatment & Conservation (WTC) Nontoxic (NT) Renewable Energy Sources (RES) Longer Life (LL)	Biodegradable (B) Recyclable (R) Reusable (RU) Others (O)

PRINCIPLES OF SUSTAINABLE BUILDING DESIGN

In the CIB Report on Agenda 21 on Sustainable Building, it states that different nations have different strategies and goals about the concept of sustainable building (Brenda et al., 2003). The study further indicates that environmental impact on the environment is the primary focus of sustainable construction and design in a universal approach. Fisher outlined five sustainable design principles which highly recommended sustainable building materials (Luc, 2003).

A. Healthy interior environment

All feasible measures must be taken to ensure that no toxic substances and gasses are released in to the indoor environment by products and construction systems. Additional measures must be taken with filtration and planting to clean and revitalize the indoor air.

B. Energy efficiency

All reasonable measures must be taken to ensure that the energy consumption of the building is negligible. Cooling, heating and lighting systems should use methods and items that reduce or minimize the use of power.

C. Ecologically benign materials

The use of building materials and products that minimize the destruction of the global environment must take all possible measures.

D. Environmental form

To achieve an effective, long-lasting and elegant relationship of areas of use, circulation, building form, mechanical systems and construction technology, all possible measures must be taken.

CONCLUSION

Sustainable building materials by default are domestically produced and imported materials that minimize transportation costs and CO2 emissions, may consist of recycled materials, have a lower environmental impact, are thermally efficient, need less energy than traditional materials, use renewable resources, are lower in harmful emissions, and economically sustainable. A green building material in every community development needs to be used correctly and contextually. The use of green building materials not only minimizes transportation costs, carbon emissions, and in most cases costs of materials, it also provides incentives for community members to create jobs and skills.

Sustainability is typically chosen by practical, technological and economic criteria as an alternative criterion for building materials. Nevertheless, with sustainability as a crucial challenge over the past decades, particularly in developed nations, the environmental burden of building materials is also becoming more important. Through seeking more environmentally friendly approaches to building and construction, the construction sector, directly or perhaps indirectly generating a substantial portion of the annual environmental destruction, may assume the responsibility to promote sustainable development. New material uses, recycling and reuse, sustainable consumer production, or green resource usage are among the avenues for solutions.

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Comparative Compressive Strengths of Concrete Using Wood Ash and Cow Bone Ash as Partial Replacement for Cement

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Abstract

The cost of cement for building construction has been a concern for developers these days, hence a comparative study of cow bone ash and wood ash as partial replacement for cement in building construction was undertaken. Chemical analysis test on wood ash and cow bone ash, bulk density test, specific gravity test, sieve analysis, slump test and compacting factor test of the freshly prepared mix were conducted to determine the suitability of the materials for concrete making. Mix ratio of 1:2:4 was adopted and replacement level 0, 5, 10, 15, and 20 percentages of cement by wood ash and cow bone ash were used. 150mm×150mm×150mm cubes were cast, cured and crushed at 7days and 28days. Thus, the compressive strength of concrete cubes whose cement has been partially replaced with wood ash and cow bone ash subjected to exactly the same conditions such as burning, curing, compaction and mixes was determined. The results indicated that cow bone ash and wood ash are slightly pozzolanic. Compressive strength of wood ash/Ordinary Portland Cement (OPC) concrete increases with age at curing, and decreases as the percentage of wood ash/OPC concrete increases, and similarly for cow bone ash/OPC concrete, indicating that the strength of concrete increases with the age of curing. However, it was found out that the compressive strength of cow bone ash/OPC concrete was more than that of Wood ash/OPC concrete. It is therefore recommended that cow bone ash would better partially replace cement in construction industry where higher strength is required.

Key words: Concrete, Cement, Cow bone ash, Compressive strength, Wood ash.

INTRODUCTION

Concrete is an important construction material which determines the strength, durability and structural performance of most construction work. Concrete, today has become one of the most popular construction material because it can be cast into just any shape, has good compressive strength, is readily available anywhere and relatively cheap in comparison with other materials such as steel or fibre composite (Gupta and Gupta, 2004). Concrete has a very good compressive strength and resistance to fire (Ede and Aina, 2015),but the tensile strength is just about 10% of the compressive strength and have been responsible for many recent researches aimed at improving the general strength of concrete (Ede and Abgede, 2015).

Concrete is a man-made composite material, a major constituent of which is natural aggregate such as gravel and sand or crushed rock. Alternatively, artificial aggregate e.g. blast furnace slag, expanded clay, broken bricks and steel shots may be used where appropriate. It is obtained by mixing cementitious material, water and aggregate (and sometimes admixtures) in required proportion. The mixture when place in form and allowed to cure, hardened in a rocklike mass known as concrete (James, 2011). Concrete occurs first in fresh state and later in hardened state. Its fresh state must undergo proper workability, consistency, setting, handling, placing, transportation and compaction for it to be satisfactory. This fresh concrete solidified and hardened after placement and developed strength over time (Joseph and Raymond 2014). Grounded into powder form, using a grinding machine. The cow bone ash was finally sieved to cement size using sieve 0.075mm

The water used was clean water obtained from a borehole tap in Gidan Kwano village Minna, free from algae, spirogyra and other biological substances.

Methods

Mix proportioning and Preparation of concrete

A nominal concrete mix ratio of 1:2:4 cement, fine aggregate and coarse aggregate along with water cement ratio of 0.5 was adopted in this study. The concrete mix design computed for this research is shown in Table 1 and 2. A weight method of batching was adopted by weighing the required quantity of cement and wood ash needed for the respective percentage replacements of wood ash with cement, then water was measured based on the specified water cement ratio. The needed quantity of sand and granite were measured and the constituent element was mixed thoroughly to a uniform paste and workable consistency. Then a standard truncated slump cone of bottom diameter 200mm, top diameter 100mm and height of 300mm was used to carry out slump test for the concrete mix for two consecutive trials, by compacting concrete mixed into the slump corn in three layers using a tamping rod 600mm long and 16mm diameter. The cone was removed gently and placed upside down beside the concrete and slump measured using meter rule. Also compacting factor test was carried out using a cylinder 300mm high and 150mm diameter by allowing concrete to fall from the compacting factor machine into the cylinder and weighed, Also another trial was compacted into the cylinder using the tamping rod and weighed too. Finally the mixed concrete was compacted into a 150 x150×150mm cube mould in three layers at 25 blows per layer using the tamping rod, allowing the concrete to harden for 24hours, after which the cube was de-moulded and submerged into a water tank 2400mm long, 1200mm wide and 800mm high to undergo curing for a period of 7days and 28days as the objectives of the study demanded. The same procedure was carried out using cow bone ash as partial replacement for cement.

Slump Test

Slump test is an empirical test carried out on fresh concrete to measure its workability. It measures the consistency of fresh concrete, that is, the ease with which concrete flows. The test is used to ensure there is uniformity for different batches of similar concrete. It measures the behavior of a compacted inverted cone of concrete under the action of gravity.

The cone was placed on a level surface. The slump cone was filled with wet concrete and tamped in three layers for 25times with a standard 16mm diameter steel rod. The top surface of the mould was leveled with the hand trowel. During the operation, it was ensured that the mould was held firmly against its base. The cone was slowly lifted immediately after filling in order to determine the height of slump.

Oxide Composition of Cow Bone Ash and Wood Ash

The chemical analysis test was carried out to determine the oxide composition of wood ash and cow bone ash as the objective of this research demanded. The chemical composition of cow bone ash and wood ash was conducted by analytical techniques according to BS 4550: part 2 (BSI, 1978). The percentage chemical compositions of the following oxides were found: Silicon dioxide (SiO_2), Calcium oxide (CaO), Aluminium oxide (Al_2O_3), Iron oxide (Fe_2O_3), Magnesium oxide (MgO), Zinc Oxide (ZnO) .The sample subjected to destructive analysis. 1.2g of the sample was weighed into a plastic container of about 100cl capacity.2cl of the aquaregia measured into the container. 1cl of the concentrated Hf added into the mixture and heated on steam bath for 30 minutes, after which 10cl of saturated boric acid added and heated for 45 minutes until digestion reached completion. The solution was allowed to cool for ten minutes and made up to the mark with distilled water and was filtered into plastic container of 100cl capacity. The sample now ready for Atomic Absorption spectrophotometer analysis. Hence, the results were obtained and are shown on table 5.

Compressive Strength Test for Concrete

The compressive test for concrete is the most important test carried out on concrete. Since concrete is high in compressive strength, therefore, there is need to determine test for the compressive strength after casting to check whether it has attained the required strength or standard that is assumed for the specific purpose. The mould box of 150mm, cubical shape was employed to cast the cubes. The concrete mix was placed in the mould in three layers; each layer was tamped not less than 25strokes of tamping rod. The cubes were stored undisturbed for 24hours at a room temperature.

At the end, the mould was stripped and the cubes were further cured in water at a room temperature. The cubes were tested at prescribed ages (7 and 28days) in compression testing machine. The concrete cubes were placed within the cast faces in contact with the platens of the testing machine and centrally positioned within it. The failure load of each cube was taken. For this project, five (5) concrete mixes with cement partially replaced with 0, 5, 10, 15, and 20% respectively were cast. Three cubes were tested for compressive strength at selected ages of 7days and 28days and the values were recorded.

RESULTS AND DISCUSSION

In this paper, five (5) concrete mixes with cement partially replaced with 0, 5, 10, 15, and 20% respectively were cast. The test results carried out in this research have been shown in Tables 1 to 7.

Table 1: Mix Design for concrete casting using wood/cow bone Ash as partial replacement for cement

Mix	Coarse (kg)	Fine (kg)	Water (kg)	Cement (kg)	Wood/bone Ash (kg)	replacement Level (%)
Mix1	28.32	14.16	3.54	7.08	0	0
Mix2	28.32	14.16	3.54	6.73	0.35	5
Mix3	28.32	14.16	3.54	6.37	0.71	10
Mix4	28.32	14.16	3.54	6.02	1.06	15
Mix5	28.32	14.16	3.54	5.66	1.42	20

Source: Authors (2019)

Table 1 revealed the mix design for the concrete production using wood ash and cow bone ash as partial replacement for cement.

Table 2 Slump Test Values Using Wood/bone ash as partial replacement for Cement

Replacement level (%)	0	5	10	15	20
Water-Cement ratio	0.5	0.5	0.5	0.5	0.5
Wood ash slump (mm)	10	10	15	10	2
Cow bone ash slump(mm)	10	30	20	18	30

Source: Authors (2019)

Table 2 revealed the slump test result, indicating that mixes with greater wood ash/cow bone ash content requires greater water content to achieve a reasonable workability.

Three cubes were tested for compressive strength at selected ages of 7days and 28days and the values were recorded. The result of the oxide composition of cow bone ash and Wood ash is presented in Table 3. The total combined content of silica, alumina and ferric oxides was 80.374%. ASTM C618 specifies that any pozzolana that will be used as a cement blender in concrete requires a minimum 70% of combined silica, alumina and ferric oxides. Hence Cow bone ash and Wood ash are suitable as pozzolanas. Also the very low SO_3 content of 0.494% is far from the maximum acceptable content of 5% specified in the same ASTM C618.

Table 3: Oxide Composition of Cow Bone Ash and Wood Ash

Constituent	% by weight for cow bone ash	% by weight for wood ash
SiO_2	78.192	72.234
Al_2O_3	1.345	5.958
Fe_2O_3	0.837	0.020
CaO	3.338	3.757
MgO	3.757	0.494
SO_3	0.494	7.674
K_2O	7.674	1.345
Na_2O	0.249	0.837
P_2O_5	2.946	3.338
Mn_2O_3	0.081	0.061
TiO_2	0.180	0.249
CI	0.061	2.946
Cr_2O_3	0.000	0.000
SrO	0.020	0.180

Source: Authors (2019)

Table 4 Compressive Strength of Concrete at 7days Using Wood Ash as Partial Replacement for Cement

Ash %	Age of curing (days)	Cube mark	Cube weight (kg)	Cube density (kg/m^3)	Failure load (kN)	Compressive strength (N/mm^2)	Average compressive strength (N/mm^2)
0	7	A	8.85 8.81 8.49	2622 2610 2516	500 550 446	22.2 24.4 19.8	22.1
5	7	B	8.64 8.81 8.75	2560 2610 2600	302 306 304	13.4 13.6 13.5	13.5
10	7	C	8.80 8.40 8.38	2607 2489 2483	288 283 276	12.8 12.6 12.3	12.6
15	7	D	8.79 8.68 8.54	2604 2572 2530	273 296 267	12.1 13.2 11.9	12.4
20	7	E	7.67 7.65 7.68	2273 2267 2276	157 176 162	7.0 7.8 7.2	7.3

Source: Authors (2019)

Table 4 revealed the result of the compressive strength of concrete at 7days using wood ash as partial replacement for concrete and Table 5 shows the compressive strength of concrete at 7days using cow bone ash as partial replacement for cement. While table 6 shows the result of the compressive strength of concrete at 28days using wood ash as partial replacement for cement.

Table 7 shows the result of the compressive strength of concrete at 28days using cow bone ash as partial replacement for cement. From the compressive strength test results it could be seen that the compressive strength of concrete using both ashes as partial replacement for cement in separate mixes increases as the age of curing increases but decreases as the percentage replacement level increases. For the control mix at 100% OPC, the compressive strength of concrete at 7days was $22.1N/mm^2$ while at 28days it was $22.8N/mm^2$. There was a decrease in the compressive strength of concrete as the percentage replacement level increases from (5 to

20%), except at a replacement level 15% for wood ash concrete which has its strength to be 13.4N/mm^2 which greater than 13.1N/mm^2 at 10% replacement level.

Table 5 Compressive Strength of Concrete at 7days Using Cow Bone Ash as Partial Replacement for Cement

Ash %	Age of curing (days)	Cube mark	Cube weight (kg)	Cube density (kg/m^3)	Failure load (kN)	Compressive strength (N/mm^2)	Average compressive strength (N/mm^2)
0	7	A	8.85 8.81 8.49	2622 2610 2516	500 550 446	22.2 24.4 19.8	22.1
5	7	B	8.34 8.71 8.76	2471 2580 2600	340 332 320	15.1 14.8 14.2	14.7
10	7	C	8.45 8.20 8.30	2504 2430 2460	288 286 275	12.8 12.7 12.2	12.6
15	7	D	8.43 8.32 8.57	2500 2465 2540	262 264 260	11.6 11.7 11.6	11.6
20	7	E	8.59 9.05 8.89	2545 2682 2634	220 216 206	9.8 9.6 9.2	9.5

Table 6 Compressive strength of concrete at 28days using wood ash as partial replacement for cement

Ash %	Age of curing (days)	Cube mark	Cube weight(kg)	Cube density (kg/m^3)	Failure load(kN)	Compressive strength(N/mm^2)	Average compressive strength(N/mm^2)
0	28	A	8.56 8.85 8.72	2536 2622 2584	518 508 510	23.0 22.6 22.7	22.8
5	28	B	8.84 8.72 8.66	2619 2584 2566	298 314 282	13.2 14.0 12.5	13.2
10	28	C	8.21 8.49 8.36	2433 2516 2477	284 302 298	12.6 13.4 13.2	13.1
15	28	D	8.85 8.63 8.60	2622 2557 2548	302 302 304	13.4 13.4 13.5	13.4
20	28	E	7.68 7.80 7.72	2276 2311 2287	264 252 278	11.7 11.2 12.4	11.8

Source: Authors (2019)

This was observed for both concretes made from partial replacement of cement with wood ash and that made from cow bone ash.

Making comparison between the compressive strengths of concrete whose cement has been partially replaced by wood ash and cow bone ash respectively, it could be seen from the compressive strength test result shown in tables 4 to 7 that concrete whose cement has been partially replaced by cow bone ash developed more strength at 7days than concrete whose cement has been partially replaced by wood ash at 7days. At 28days, the compressive strength of concrete whose cement has been partially replaced by cow bone ash developed greater

strength than the wood ash concrete. Therefore, cow bone ash would be better to partially replace cement in construction industry where strength is required.

Table 7 Compressive Strength of Concrete at 28days Using Cow Bone Ash as Partial Replacement for Cement

Ash %	Age of curing (days)	Cube mark	Cube weight (kg)	Cube density (kg/m^3)	Failure load (kN)	Compressive strength (N/mm^2)	Average compressive strength (N/mm^2)
0	28	A	8.56 8.85 8.72	2536 2622 2584	518 508 510	23.0 22.6 22.7	22.8
5	28	B	8.37 8.42 8.56	2480 2495 2536	484 478 490	21.5 21.2 21.8	21.5
10	28	C	8.36 8.45 8.42	2477 2504 2495	464 478 460	20.6 21.2 20.4	20.7
15	28	D	8.80 8.71 8.62	2607 2581 2554	308 304 310	13.7 13.5 13.8	13.7
20	28	E	7.65 7.70 7.81	2267 2282 2314	284 290 276	12.6 12.9 12.3	12.6

Source: Authors (2019)

CONCLUSION

This study has undergone the comparative compressive strength of concrete whose cement has been partially replaced by wood ash and cow bone ash subjected to exactly the conditions. From the experimental results, the following conclusions have been drawn:

The compressive strength of concrete decreased with an increase in the amount of cow bone ash and wood ash respectively. Also the density of concrete also reduced with an increase in the amount of both ashes. Furthermore, the compressive strength of concrete increased with the age of curing as seen tables 4 to 7. Cow bone ash concrete developed greater compressive strength than that of wood ash concrete at 28days.

RECOMMENDATIONS

- Water-cement ratio should be increased for better workability if any of the ashes (cow bone ash and wood ash) is to be used to partially replace cement, owing to the fact that the slump test result at 10% replacement was 15mm and at 15% was 10mm for wood ash. These values are quite low.
- In view of the above conclusion, it is therefore recommended that cow bone ash would be better for partial replacement of cement in the construction industry.

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Assessing Some Mechanical Properties of Reinforcement Bars Made from Recycled Metals as a Panacea to Sustainable Use of Reinforcement as Building Material

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Abstract:

Recycling has been identified as one of the ways of attaining a sustainable supply of building materials. However, the use of substandard materials has been linked with substandard structures that often lead to building collapse. Against this backdrop, this paper aim at assessing the mechanical properties of reinforcement bars produced from recycled metals with a view of attaining sustainability in its use as a building material. The research adopted a quantitative research approach where a total of 24 high yield reinforcement bars made from recycled metals of sizes 20mm, 16mm, 12mm and 10mm diameter were subjected to tensile test using 500 KN capacity tensile testing machine. Veneer calliper was used to ascertain diameter of the bars. Result obtained was used to determine ultimate tensile strength, yield stress and percentage elongation. Findings revels that the reinforcement bars diameter are lower than that expected, have yield stress lower than 460 N/mm2 as required by BS4449-1997, and lower than that of newly drawn reinforcement. The result further shows that the material is ductile because all the samples have a percentage elongation more than the allowable. The study recommends use of reinforcement made from recycles metals only for light construction works, and effort to be made in improving quality of reinforcement made from recycled metals

Keywords: Construction, Recycling, Reinforcement, Strength, Sustainability,

INTRODUCTION

Materials are the essential components of building construction. The chemical, physical and mechanical properties of materials as well as a suitable design are accountable for the building's mechanical strength; building materials are usually selected through functional, technical and economical requirements (Umar, Khamidi, and Tukur, 2014). Building materials are used for producing buildings or are used as semi-finished products for the production of other building materials. Building materials have an important role to play in this modern day technology. Although their most important use is in construction activities, no field of engineering is possible without their use. An important contributor to the national economy is the building material industry as its output governs both the rate and quality of construction.

Globally, infrastructure and building construction consumes 60 % of the raw materials extracted from the Earth (Bribian et al, 2011). From this volume, building accounts for 40%, in other words 24% of these global extractions. In the US, with 4 % of world's population, the consumption of resources is at a staggering 25 % of total resources available in the world (Spence and Mulligan, 1995).About 50% of all global capitals go into the construction industry with a definite example being that 70% of all the timber is used for the production of buildings.

Clough (1994) discover that about 1-10% by weight of the purchased construction materials depending on the type of material leaves the site as waste. According to Spence and Mulligan, (1999), about 50 to 80% of the construction waste management and reduction can be considered an issue that focuses on the danger of depletion of materials used in the construction industry such as timber, sand and gravel. In order to avoid wastage of these limited resources the construction industry should implement a suitable waste management plan.

The problem of depletion of non-renewable earth resources necessitates the need for a sustainable approach to material usage. The term sustainability originated in the Brundtland report in 1987 who defined sustainability as "sustainable development" and sustainable

development as" development that meets the needs of the present without compromising the ability of future generations to meet their own needs". One way of achieving sustainable use of resources is through recycling (Drexhage and Murphy, 2010).

Recycling is the process of converting waste materials into reusable objects to prevent waste of potentially useful materials, reduce the exploitation of fresh raw materials, reduce energy usage, air pollution and water pollution by decreasing the need for "conventional " waste disposal and lowering greenhouse gas emissions(Tsubramani and Kumaran, 2015). Recycling is a key component of modern waste management. Metals are being recycled from metal waste called scrap metals. Scrap metals are reprocessed into reinforcement bars for construction work.

Reinforcement bars produced from scrap metals must meet the minimum acceptable standard. This is to avoid damages to structure or even building collapse which have become a major concern in Nigeria. One of the factors pointed out by Fagbenle and Oluwunmi (2010) that leads to the collapse of buildings in recent times is the use of substandard or counterfeit materials. Some materials used by contractors do not certify the required standard needed to produce the designed structural requirement of the structure this would be detrimental to the structure in a long run. It is against this backdrop that this paper attempt to find the quality of reinforcement bars produced from scrap metals.

LITERATURE

Sustainability

Environmental deterioration has captured the world's attention and has been one of the most discussed subjects locally, nationally and globally (Bentivegna et al., 2002). Langston and Ding (2001) theorized that the world is in crucial environmental catastrophe.

In a bid to curb the adverse effect of human activities on the natural environment the term sustainability was coined, this concept was originally coined in forestry in Germany where it means never harvesting more than the forest yields in growth. The term sustainability was first used with meaning in 1713 (Kuhlman & Farrington, 2010). Sustainability as a policy concept has its origin in the Brundtland report of 1987 which defined sustainability as "sustainable development" and sustainable development as "development that meets the need of the present without compromising the ability of future generations to meet their own need".

Waste and Waste Management

A large volume of waste results from the production, transportation and use of materials (Ofori and Chan, 1998; Kein et al., 1999). Waste materials are being generated on construction sites from the conception of a building up until its demolition. Construction waste is seen to be excess resources than required for infrastructure production or in the construction process. Ofori and Chan (1999) views material waste as any material from the construction site or used within the construction site itself for the purpose of landfilling, incineration, recycling, reusing or composting other than the intended specific purpose of the project due to materials damage, excess non-use or non-compliance with the specifications or being a by-product of the construction process.

Recycling

Teodoro (2011) defines recycling as the process of converting waste materials into reusable objects to prevent waste of potentially useful materials, reduce the exploitation of fresh raw materials, reduce energy usage, air pollution(from incineration) and water pollution(from

landfilling) by decreasing the need for conventional waste disposal and lowering greenhouse gas emissions. He concludes that recycling of waste would reduce a large quantity of CO_2 produced by waste and would pose as a good substitute for the use of natural building materials in addition recycling generates environmental, economic and social benefits.

Research problem

Due to the activities of humans on the earth, the natural environment is depleting and if the exploitation of the earth resources continues, it would lead to the scarcity of resources thereby affecting the supply of building materials for the construction industry and future generations. The construction industry is known to contribute greatly to waste production which also has an adverse effect on the environment.

Langston and Ding (2001) discover that about 1-10% by weight of the purchased construction materials depending on the type of material leaves the site as waste. According to them, about 50 to 80% of the construction waste management and reduction can be considered an issue that focuses on the danger of depletion of materials used in the construction industry such as timber, sand and gravel. In other to minimize the waste produced several ways of waste management are being devised of which recycling is one

Recycling metal has several benefits for the environment, compared with making products from recycled metal the manufacture of new metal from mined ore releases far greater amount of greenhouse gas emissions. But recycled metal that is of low quality would only produce a sustainable construction but not a durable and suitable construction. .

The use of sub-standard material would in no doubt produce a sub-standard building. Oloyede, et al (2010) attributed one of the causes of building collapse to the use of substandard building materials.

According to Hellemans (2013) "recycled materials are often of lower quality than the materials from which they were derived. Sustainability and Quality are two factors that should be greatly considered during construction by the professional but most times they are the factors that are been neglected.

It is in view of the above findings that this research on the quality and suitability of sustainable material (recycled steel) gotten from two major suppliers of in Zaria was been conducted.

MATERIALS AND METHODS

Materials

Mukhtar (2014) carried out tensile test on reinforcement bars. He subjected high yield newly drawn bars of diameters 10mm, 12mm, 16mm, and 20mm to tensile test as they are the most commonly used reinforcements for construction. For this paper, recycled high yield bars were sourced from two (2) different sources of diameters: 10mm, 12mm, 16mm and 20mm. they were all subjected to universal tensile stresses.

Test Samples

Two (2) samples of recycled steel were subjected to tensile stresses with each sample consisting reinforcement bars of diameters 10mm, 12mm 16mm and 20mm. A total of 24 high yield steel bars were brought to the materials testing laboratory, department of Mechanical Engineering, Ahmadu Bello University Zaria to determine their mechanical properties.

Testing Machine

The test sample were cut in in a length of 1000mm and subjected to tensile stress. For this research the machine used to carry out the test is the "500KN Capacity Universal Testing Machine- DENISON with model number; T42B3".

Tensile Test

The tensile test is the most common test applied to materials (Onouye, 2005). When carrying out this test, the material was subjected to a tensile force. In other words the material is been stretched or pulled apart. This test is widely used to indicate the strength, ductility and toughness of the metal. The test consists of straining a test piece by tensile stress, generally to fracture with a view of determining one or more of the mechanical properties. For this study the following properties would be determined.

1. The Diameter of the rod(physical test)
2. The Yield strength in N/mm²
3. The Ultimate tensile strength in N/mm²
4. The Percentage elongation (%)

ANALYSIS OF RESULTS

The readings from the test were used to determine the yield strength, ultimate tensile strength and percentage elongation using the following formula stated by (Onouye, 2005)

$$\text{Yield strength (N/mm}^2\text{)} = \frac{yield\ force}{original\ cross\ section\ area} \quad (1)$$

$$\text{Ultimate tensile strength (N/mm}^2\text{)} = \frac{maximum\ force\ the\ specimen\ can\ withstand}{original\ cross\ section\ area} \quad (2)$$

$$\text{Percentâge elongation (\%)} \quad \frac{final\ length - original\ length}{original\ length} * 100 \quad (3)$$

The results were calculated and the values were compared with the stated standards in the BS4449-1997

RESULTS AND DISCUSSION

Tensile strength is the most dominant charateristics required of reinforcement bars (Mukhtar, 2014. The required mechanical properties of reinforcement bars requires in accoradance to British Standard (BS) are presented in Table 1.

Table 1: Mechanical properties of reinforcement bars

STANDARD CODES	YIELD STRESS (N/mm²)	ULTIMATE STRESS (N/mm²)	ELONGATION (%)
BS4449	500	600	14

Source: BS 4449, 1997. This value applies to all sizes of reinforcement.

Table 1 present requirements of BS 4449 (1997) of minimum required yield steel, ultimate stress and percentage elongation allowable for high yield steel. These values were used to compare with those obtained from reinforcement bars made from recycled metals.

Size of Samples

The size of the sample help in determining properties of reinforcement. The diameter of the samples was measured using callipers. The result is presented in table 2.

Table 2: Diameter of Reinforcement Bars

REQUIRED DIAMETER (MM)	DIAMETER OF SAMPLE A (mm)	DIAMETER OF SAMPLE B
20	19	19
16	15	14.4
12	11.4	11.0
10	9.4	9

Source: Laboratory Test (2018).

The result in table 1 show the diameter of the two samples in comparison with the required diameter.

The result indicated that non of the sample has meet the required size. This result implies that this type of steel when used will have a reduced area of reinforcement.

Tensile Test

The result of tensile strength of sample A is presented in Table 3 while Table 4 is result of tensile strength of sample B.

Table 3. Tensile test result of Sample A

Diameter (mm)	Yield Stress (N/Mm^2)		Ultimate Stress (N/Mm^2)		Elongation (%)	
	A	B	A	B	A	B
Y20	441	471	709	597	12	24.33
Y16	177	585	485	720	12	22.33
Y12	414	637	643	788	12	16.00
Y10	576	443	765	652	12	20.67

Source: Laboratory Test (2018).

The results obtained shows that the re-bar of Y20 has an ultimate tensile strength of 709N/mm² and a percentage elongation of 25% which satisfies the minimum standard of 600N/mm² and 14% respectively; it also shows a yield stress of 441N/mm² which is not up to the minimum standard of 460N/mm². The shortcoming of the Y20 reinforcement bar to satisfy the minimum yield stress required makes it unsuitable for use even though it satisfies the ultimate tensile strength and % elongation as a low yield point would give no sign of intending failure of the structure.

The results obtained for the Y16 bar shows that this rod satisfies only the condition stated for percentage elongation (% EL) and does not meet up with the minimum standards of 460N/mm² for yield strength and 600N/mm² for the ultimate tensile strength therefore is unsuitable for use. The result obtained from the Y12 re-bar satisfies the ultimate tensile strength and the percentage elongation of 600N/mm² and 14% respectively but it failed to satisfy the minimum

acceptable standard for yield strength having a yield strength of 414N/mm² which is less than the stated 460N/mm².

The result obtained for Y10 satisfies all the standard with results of 576N/mm², 765N/mm², 15.67% for the yield strength, tensile strength and percentage elongation respectively. This makes it suitable for use for construction work.

Similarly, the tensile result for sample B is shown in table 3. the result tensile test carried out on sample B high yield reinforcement comprising of Y20, Y16, Y12 and Y10. The results obtained from the test carried out on the Y20 re-bar shows that it satisfies the recommended yield strength of 460N/mm² with a yield strength of 471N/mm² which exceeds the given standard and also satisfies the recommended percentage elongation of 14% with a percentage elongation of 20.67% but the re-bar fails to satisfy the standard tensile strength of 600N/mm² required thereby making it unsuitable for use as the structure would fail without warning.

The result obtained for the Y16 and Y12 re-bar shows that it satisfies all the recommended standards with y16 having a yield strength of 585N/mm², tensile strength of 720N/mm², percentage elongation of 22.33% and Y12 having a yield strength of 637N/mm², a tensile strength of 788N/mm² and a percentage elongation of 16% this shows the suitability of this rod to be used for construction work as the structure would give signs before failure.

The result obtained from the test on then Y10 re-bar show that the bar satisfies the recommended standard for the ultimate tensile strength and the percentage elongation with an ultimate strength of 652N/mm² and a percentage elongation of 20.67 but fails to satisfy the standard for the yield strength with a yield strength of 443N/mm² which is below the required 460N/mm² thereby making it unsuitable for use.

CONCLUSIONS

Different samples of high yield reinforcement bars produced from recycled metals subjected to tensile test. The yield stress, ultimate stress and percentage elongation were subsequently calculated.

The Results of mechanical properties on reinforcement made from recycled metals show inconsistencies in strength values even from the same source. Some of the tested samples fail to meet minimum requirements.

The paper conclude that recycled metals can be used as a sustainable source of reinforcement for construction. However, the paper recommend that careful test should always be carried out on any batch of reinforcement brought to site for construction before it can be used. Site engineers should not rely on previous test carried out on similar materials even if they are from same source.

Furthermore, it desirable to carry out more tests on samples of reinforcement bars made from recycle metals in further researches. Similarly, further researches should be carried out to identify the causes of reduced strength of reinforcement nars made from recycle metals and how to mitigate such problems.

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Optimizing the Compressive Strength of Binary Mixtures of Laterite-Sand Cement Mortar

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Abstract:

The use of conventional cement-sand material for the production of mortar for permanent ferro-cement formworks and bedding & jointing sandcrete block walls has been in use as traditional material. An attempt to substitute partially, with binary mixtures of laterite to introduce both cement and plastic bonds as a property of the composite material is proposed to reduce the cost of cement, the binder. A methodology for specification writing procedure using a computational approach is introduced using the Central Composite Design mixture experimental design (CCD). The properties of the composite material were investigated and found to satisfy basic NIS standards. It enabled lower cement contents with corresponding higher minimum compressive strength to be achieved, which is well above the minimum requirement of 2.8 N/mm^2 NIS standards, thus making the replacements suitable for permanent ferro-cement and bedding & jointing masonry works.

Keywords: mortar, binary, compressive, bedding and jointing

INTRODUCTION

Conventional cement-sand mortar for bedding and jointing block walls or for permanent ferro-cement formworks is a composite material obtained by mixing cement, fine aggregate and water. Introducing alternative materials or blending are primarily aimed at improving the properties or for cost reduction, and it requires developing basis to confirm the acceptability of its properties for a series of acceptance criteria (Biju et al., 2018; BS EN 771-1: 2011). Cement-sand mortar for bedding and jointing is an integral total of the cost of block wall per square metre. Apart from bedding and jointing purposes, the composite material is also responsible for creating a uniform stress distribution of dead loads from the block walls and therefore the knowledge of both its wet and hardened properties is fundamental (Vladimir *et al*., 2011). The uniqueness in the use of laterite as a partial replacement of sand is its plasticity characteristics, thereby introducing both cement and plastic bonds in the composite material, to obtain high workability, plastic and cheaper mix at low cement content. Cement-sand mortars are also used as a basic finishing material on block walls such as plastering, rendering and/or on screeded beds, as a ferro-cement material and also blended with laterites for moulding sandcrete blocks (Kolapo *et al*., 2007; Joshua *et al*., 2014). Its usage is tied to good sound insulation and resistibility to water penetration. A specifications writing procedure is presented in order to obtain this improved characteristic properties of introducing 'plastic and cement bonds'

Constituent proportions selection for cement-sand mortar is necessary to achieve expected properties. Such properties include particle size distribution, specific gravity, shape and surface texture. They influence both the properties of the mortar in both their fresh and hardened states.

GRADING AND SOURCES OF SAND FOR CEMENT-SAND MORTAR PRODUCTION

Fine aggregates referred to as sand is generally described as aggregates passing 4.75 mm aperture size openings and retained on 75 microns sieve openings irrespective of their source. The requirement is that it should generally be free from silt, clay and deleterious substances. It

can be sourced from a river bed or erosion sand, crushed stones or naturally deposited (Neville, 1993). The result of sieve analysis, otherwise called gradation describes the distribution of the particle sizes usually represented on a log-linear graph. The vertical scale, called the ordinate represents the percentage passing, and the horizontal scale called the abscissa on a log scale, represents the size. Visually, the continuous curve represents a well-graded deposit with all the size ranges present in the deposit.

BS 812 (1990) classification uses four grading bandwidths called grading zones over which a grading curve should lie within it. The zones are 1, 2, 3 and 4. Plaster sand called Zone 4 is almost naturally occurring while others can be sourced from river beds or as erosion soil (Neville, 1993). In contrast, BS EN 933-1: 2012 uses three classifications for sand. These include coarse sand with grain size within 2 to 4.75 mm range, medium sand with grain size within 0.425 to 2 mm range and fine sand with a grain size up to 0.425 mm.

Fine aggregates are classified primarily based on gradation requirements which are a reflection of the specific surface, which represents the surface area per unit weight of aggregate. Specific surface increases with the reduction in the size of the aggregate particle. This is a reflection of the fundamental proposition that the surface area of an equivalent sphere is proportional to the second power of its diameter. The volume is therefore proportional to the third power of its diameter, which implies that the specific surface is inversely proportional to its diameter, that is:

$$A \propto d^2 \qquad (1a)$$

$$V \propto d^3 \qquad (1b)$$

$$SP \propto \frac{1}{d} \qquad (1c)$$

$$where\ d = diameter, A = surface\ area, V = volume\ and\ SP = specific\ surface$$

This proposition, however, does not hold with laterite soils and its composites because the cementing materials themselves depend on the mineralogical composition. This implies that the finer the particle size, the higher the specific surface.

The ASTM method of classification of soil grades uses the fineness modulus, which is a dimensionless quantity obtained as a total cumulative percentage passing divided by 100. The higher the value of a fineness modulus, the coarser the grading.

Blending Laterites for Cement-Sand Mortar Production

Earlier definition of laterite according to Gidigasu (1976) is described as a light to dark homogeneous, vesicular, unstratified and clinker-like soil material consisting mainly of oxides and hydroxides of aluminium, iron, manganese and silica. It hardens on extraction and exposure. It is described as a class of pedogenics where the cementing materials are the sesquioxides content and should typically constitute not less than 50 per cent of the mineralogical composition (Singh, 2006; Aguwa, 2009). The process called blending is primarily used in road works where lateritic materials from different sources with different properties are used. The combination from two different sources are aimed at re-confirming if desired specification requirement such as plasticity or grading are met. In road base and sub-base designs, a graphical method for proportioning laterite materials from sources have been well developed, (Singh, 2006). Here, laterite material is used to replace a percentage of sand in the composite material.

This lateritic material in its natural form is cementitious possessing plastic bonds in itself even without the addition of cement. However, where the plasticity index, a physical property of the material is in excess (Singh, 2006).

Among notable reference classification systems of laterites are the Unified Soil Classification System (USCS) and the American Association of State Highways and Transport Officials (AASHTO) soil classification reference data. The BS 1377 (1990) is a commonly used laboratory method for carrying out physical properties of laterites to obtain the level of plasticity of the sample, notably the liquid limit, plastic limit, plasticity index and shrinkage limit tests.

Workability of Mortars

Workability of mortars, a wet property of the mixture influences the ease with which masons carry out both mixing and placing as well as the property of the hardened property such as compressive strength, bond strength and durability. Plasticity and cohesion are difficult to measure in-situ; consistency test is therefore frequently used as a measure of the workability (Neville, 1993).

Cement

Cement, a binder is generally a calcareous (lime) and an argillaceous (silica and alumina) material (Neville, 1993). It is the most used material for bonding aggregates and fragments together in cement-sand composite material. Portland cement products are manufactured in a carefully controlled process. However, as a result of environmental pollution, a modification in the manufacturing process to reduce carbon emission has evolved by adding up to 5% limestone in the course of clinker grinding to produce what is known as a Portland limestone cement in accordance with BS EN 197-1: 2016.

The Central Composite Design (CCD) Quadratic Model

This is a mixture experimental design employed for modelling responses of interest as a second-order quadratic model and has gained increasing wider application in mix design for concrete composites (Simon et al,. 1999). The second-order quadratic model takes the form (Montgomery, 2001)

$$y = \beta_0 + \sum_{i}^{k} \beta_i x_i + \sum\sum_{i<j} \beta_{ij} x_i x_j + \sum_{i}^{k} \beta_{ii} x_i^2 \qquad (2)$$

where *"y"* is the response of interest. The values x_i and x_j are the components. The value β_0 is the intercept, and the parameters β_i and β_{ij} represent the linear and quadratic coefficients fitting the mixture experimental data for both the linear and interactive terms, respectively.

The technique is commonly used in mixture proportioning, particularly to develop, improve and also optimize the constituent mixture proportions.

There CCD is a scheme with a characteristic rotatability design which implies that predicted values should have equal variance at locations equidistant from the origin (Montgomery, 2001). A CCD run specifies a $2^n + 2n + 1$ design points for a full quadratic model with n factors, representing the factorial, the axial and centre points. The inclusion of the axial points, alpha (α) is primarily to account for any missing linear expression in the second-order quadratic model.

The experimental region can be designed by a simple lower and upper limits on the design variables of the type:

$$x_{il} \leq x_i \leq x_{iu} \qquad i = 1, \ldots, n$$

where x_{il} and x_{iu} represent lower and upper bound of the variables. The coded variable x_i is represented as

$$x_i = \frac{2x_i' - x_{il} - x_{iu}}{x_{iu} - x_{il}} \tag{3}$$

and the normalized coded variable $\boldsymbol{x_i}$ can now be bonded within the cube as

$$-1 \leq x_i \leq 1$$

This represents a dimensionless coded variable which can also be translated to actual variables using the expression:

$$x_{\boldsymbol{actual}} = x_{min} + \frac{(x_{coded} + 1)}{2} * (x_{max} - x_{min}) \tag{4}$$

where x_{actual} is the un-coded value, and x_{min} and x_{max} represent the uncoded lower and upper values corresponding to ±1 coded values.

The construction of this design matrix is also implementable using the Design Expert statistical software (Design Expert, 2000). The advantage of this type of experimental design procedure is that it has an important implication for specification writing, especially in site production. It can yield a target strength which implies that at least 95 per cent of the results are expected to fall within the normal distribution curve, with probability $p \leq 0.05$

METHODOLOGY

The samples were produced using 50mm x 50mm x 50mm cube mould specimen samples preparation. The specimen sample size corresponding to the design points which corresponds to 20 runs of centre and non-centre points.

Portland cement

Ordinary Portland Limestone Cement Grade 42.5 produced by Dangote Cement Company was purchased from within the Minna building materials market, Niger State, and was used as the binder.

Fine aggregate

The fine aggregate used for the investigation was medium sand complying with BS EN 933-1:2012. These characterization tests were conducted to classify the sample such as sieve analysis, specific gravity and bulk density. The fine aggregate sample is continuously graded and in air-dry condition

Estimation of constituent proportions

The absolute volume method was used for estimating the mixture proportions using Equation 5 (Neville, 1993)

$$\frac{water}{Gs_{water} \times 1000} + \frac{cement}{Gs_{cement} \times 1000} + \frac{sand + laterite}{Gs_{sand+lat} \times 1000} = 1 \tag{5}$$

$$\boldsymbol{where}\ Gs = specific\ gravity\ of\ 1.0, 3.15\ and\ 2.62\ for\ water, cement\ and\ 'sand + laterite'\ respectively$$

A starting water-cement ratio of 0.5 was used for the estimation of the quantities. It was later revised to reflect the mixing water required to obtain the needed workability using the flow metre apparatus. The mixing water was used to recalculate the proportions in Equation 5. The resulting proportions for the lower and upper limits on water, cement and aggregates are shown in Equation 6

$$\left.\begin{array}{l} 0.263 \le x_1 \le 0.277 \\ 0.056 \le x_2 \le 0.090 \\ 0.647 \le x_3 \le 0.668 \end{array}\right\} \quad CCD_{CONTROL}; \qquad (6a)$$

$$\left.\begin{array}{l} 0.340 \le x_1 \le 0.377 \\ 0.051 \le x_2 \le 0.076 \\ 0.547 \le x_3 \le 0.609 \end{array}\right\} \quad CCD_{BINARY}; \qquad (6b)$$

RESULTS AND DISCUSSION

The mixture proportions both in coded and actual variables for cement-sand mortar mixes for the control, and binary mixtures are shown in Tables 1 and 2. Columns 1, 2 and 3 represent the experimental numbers in the standard order, the corresponding factorial point and the value of the coded variables, respectively. Similarly, columns 4, 5 and 6 represent the value of the actual variables corresponding to the design points, the responses at 7 and 28 days, respectively.

Table 1: Mixture proportions in coded and actual variables for cement-sand control mixture

(1)	(2)	(3)			(4)			(5)	(6)
The design matrix		x_1=water; x_2=cement x_3=sand (control)						$Y_1=f_{c7}$	$Y_2=f_{c28}$
		Variables						Response	
		coded			actual (kg)			N/mm^2	N/mm^2
Experiment no.	Point	x_1	x_2	x_3	x_1	x_2	x_3	Y_1	Y_2
1	Factorial	-1	-1	-1	262.89	175.00	1696.10	6.88	7.47
2	Factorial	1	-1	-1	276.50	175.00	1696.10	3.31	4.96
3	Factorial	-1	1	-1	262.89	282.68	1696.10	6.51	8.56
4	Factorial	1	1	-1	276.50	282.68	1696.10	6.44	7.92
5	Factorial	-1	-1	1	262.89	175.00	1750.01	2.93	4.59
6	Factorial	1	-1	1	276.50	175.00	1750.01	3.84	6.16
7	Factorial	-1	1	1	262.89	282.68	1750.01	9.00	10.41
8	Factorial	1	1	1	276.50	282.68	1750.01	9.29	11.32
9	Axial	-1.682	0	0	258.25	228.84	1723.05	5.00	7.52
10	Axial	1.682	0	0	281.14	228.84	1723.05	4.41	9.36
11	Axial	0	-1.682	0	269.70	138.28	1723.05	2.93	4.48
12	Axial	0	1.682	0	269.70	319.40	1723.05	11.61	15.76
13	Axial	0	0	-1.682	269.70	228.84	1677.71	7.56	12.00
14	Axial	0	0	1.682	269.70	228.84	1768.39	5.87	7.77
15	Centre	0	0	0	269.70	228.84	1723.05	5.21	8.37
16	Centre	0	0	0	269.70	228.84	1723.05	5.23	8.36
17	Centre	0	0	0	269.70	228.84	1723.05	5.37	8.36
18	Centre	0	0	0	269.70	228.84	1723.05	5.32	8.37
19	Centre	0	0	0	269.70	228.84	1723.05	5.37	8.37
20	Centre	0	0	0	269.70	228.84	1723.05	5.32	8.37

Table 2: Mixture proportions in coded and actual variables for binary cement sand mixture

(1)	(2)	(3)			(4)			(5)	(6)
The ccd design matrix		x_1=water; x_2=cement x_3=sand + laterite (binary)						$Y_1=f_{c7}$	$Y_2=f_{c28}$
		Variables						Response	
		coded			actual (kg)			N/mm^2	N/mm^2
Experiment no.	Point	x_1	x_2	x_3	x_1	x_2	x_3	Y_1	Y_2
1	Factorial	-1	-1	-1	340.03	159.64	1432.82	3.76	6.68
2	Factorial	1	-1	-1	377.31	159.64	1432.82	3.36	6.15
3	Factorial	-1	1	-1	340.03	238.80	1432.82	4.44	6.75
4	Factorial	1	1	-1	377.31	238.80	1432.82	5.04	7.33
5	Factorial	-1	-1	1	340.03	159.64	1596.36	3.77	6.07
6	Factorial	1	-1	1	377.31	159.64	1596.36	3.44	5.97
7	Factorial	-1	1	1	340.03	238.80	1596.36	5.47	8.36
8	Factorial	1	1	1	377.31	238.80	1596.36	4.96	8.19
9	Axial	-1.682	0	0	327.31	199.22	1514.59	4.32	7.80
10	Axial	1.682	0	0	390.02	199.22	1514.59	3.72	7.15
11	Axial	0	-1.682	0	358.67	132.64	1514.59	2.72	5.84
12	Axial	0	1.682	0	358.67	265.80	1514.59	5.16	7.80
13	Axial	0	0	-1.682	358.67	199.22	1377.06	3.67	6.44
14	Axial	0	0	1.682	358.67	199.22	1652.12	4.00	6.21
15	Centre	0	0	0	358.67	199.22	1514.59	4.04	7.05
16	Centre	0	0	0	358.67	199.22	1514.59	4.05	7.03
17	Centre	0	0	0	358.67	199.22	1514.59	4.05	6.97
18	Centre	0	0	0	358.67	199.22	1514.59	4.05	7.03
19	Centre	0	0	0	358.67	199.22	1514.59	4.05	7.15
20	Centre	0	0	0	358.67	199.22	1514.59	4.04	7.04

The models that explain the fitted data are as shown in Equations 7 and 8, which represents the response predictions for mortar strength at 7 and 28 days for cement sand mortar and binary mixtures of sand/laterite mixtures. By default, the CCD model consists of a constant term and a coefficient of the variable term which describes the responses from input data. This model represents the statistical significance with a low probability value of $p \leq 0.05$ and shows that both the model, the coefficient and the intercept are significant and should be included in the model.

$$fcontrol; \quad fc7 = -3.11682 + 0.039274 * Cement \qquad (7a)$$

$$fcontrol; \quad fc28 = -2.16033 + 0.046255 * Cement \qquad (7b)$$

$$fbinary; \quad fc7 = 0.54007 + 0.017899 * Cement \qquad (8a)$$

$$fbinary; \quad fc28 = 3.61276 + 0.016751 * Cement \qquad (8b)$$

Contour plots for the response predictions can also be produced, which can then be used to identify the conditions that give the extremum visually in one-dimensional view. A contour plot is a graphical representation which shows only two (2) components at a time by default. In these models, the interaction terms are not included because they are not significant in the model. The general form of the second-order quadratic model is of the form $a + bx$. Sample contour plot 28-day compressive strength result for the control mix is shown in Figure 1

The mortar strength for bedding and jointing block walls should not be less than the block strength. In accordance with NIS 87 (2004), this is suitable because the mortar can be produced far above the value of 2.8N/mm^2 specified.

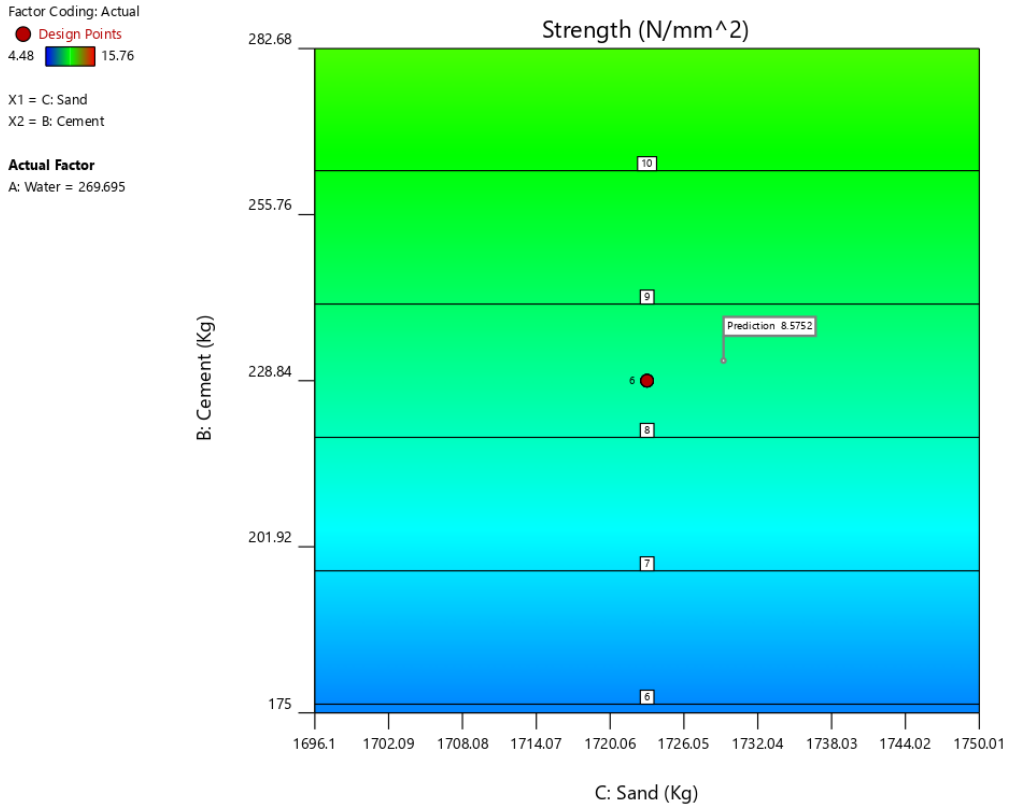

Figure 1: Sample contour plot for compressive strength at 28 days

Mixing Water Requirement and Cement Quantity

A simple linear relationship can be written for mixing water requirement and the quantity of aggregate for the composite mix. The limits in equations 6(a) and 6(b) was used to generate the points within an augmented [3,2] Simplex lattice design representing 10 design points. By multiplying the relative absolute volumes of the component mixes by their densities, the proportions can be obtained for all the design points. This method also enables fitting points that can yield a second order-quadratic polynomial expression, (Montgomery, 2001) and thus obtain a linear mathematical relationship connecting water requirement to the cement: sand/laterite ratio per one cubic meter of the mix. Similarly, the fine aggregate quantity can be regressed in a similar manner thus yielding the linear expression in Equations 6 and 7 using a probability $p < 0.05$ statistical significance,

$$Water_{control}; \qquad W_{control} = 291.267 - 159.860 * \left(\frac{Cement}{sand}\right) \qquad (9a)$$

$$Water_{binary}; \qquad W_{binary}\, Y = 335.063 + 166.076 * \left(\frac{Cement}{sand{:}\, Laterite}\right) \qquad (9b)$$

$$Aggregate_{control}; \qquad A_{control} = 1849.236 - 0.555 * Cement \qquad (10a)$$

$$Aggregate_{binary}; \qquad A_{binary} = 1717.380 - 0.992 * Cement \qquad (10b)$$

Example of Component Mix Selection

This method starts as an iterative process by selecting a cement quantity within the limits to obtain the desired strength. The procedure is stated thus:

i) Calculate the quantity of cement from within the limits suggested

ii) Substitute the cement quantity in the equation expressing the compressive strength of mortar cube

iii) Estimate the quantity of fine aggregates from the equation relating the calculated cement quantity

iv) Estimate the quantity of water from the equation relating the ratio of cement/fine

v) Calculate cement: laterite ratio

Using the same problem statement:

i) Starting with the lowest limit of cement in Equation 6(a) (absolute volume = 0.056) represents 176.4 kg of cement, that is (0.056 x 3150 = 176.4 kg), where unit weight of cement is 3150 kg/m^3.

ii) Substituting the cement quantity in Equation 7(b) $fc = -2.16033 + 0.046255 * 176.4$

iii) This yields a compressive strength value of 6.0 N/mm^2.

iv) The corresponding quantity of fine aggregates from equation 10(a) relating the calculated cement quantity is $.e = 1849.236 - 0.555 * cement$; gives (1849.236 - (0.555*176.4)) = 1751.334 kg/m^3.

v) The corresponding quantity of water from equation 11(a) relating the calculated cement/laterite ratio is $water = 291.267 - 159.860 * \frac{cement}{sand}$. This substitution gives = (291.267 - (159.267*(176.4/1751.334))) = 275.23 kg/m^3

vi) The cement:sand ratio is 176.4/1751.334 ≈ 1:6

At the same cement content and substituting the values in the example, the compressive strength of binary mixture yields higher strength i.e, 6.6 N/mm^2 > 6.0 N/mm^2.

CONCLUSION AND RECOMMENDATIONS

Based on the CCD method, it has been shown that cement-sand mortar mixes blended with binary replacement of silica sand with laterite can be designed to meet a specified requirement. It allows the use of lower cement quantities to get the required flow or workability because of the cement and plastic bonds. This makes it suitable for ferro-cement formwork construction and bedding & jointing blockwalls. Specification writing for site production is possible, using this approach.

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Assessment of Lean Techniques for Building Materials Waste Minimisation in Abuja, Nigeria

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Abstract:

Lean construction techniques have been known globally as a production system with a high capacity of waste minimisation. However, studies revealed a sub-optimal understanding of the construction professionals on the relevant lean techniques for building material waste minimisation in Nigeria. Thus, this paper assessed lean techniques for material waste minimisation in building projects in Abuja, Nigeria. The study adopted a survey design approach using quantitative data. Data was purposively collected using well-structured questionnaire administered to 320 construction practitioners (project managers, contractors, heads of waste management departments, and consultants) of 80-active building construction sites that are practicing lean within Abuja. A total of 189 questionnaires were retrieved from the 320 distributed. The collected data was analysed using frequencies, percentages and Relative Importance Index (RII). The study found that lean techniques relevant to the pre-construction stage of building projects are: visual management; waste disposal management; and space utilisation management, with average RII values of 0.78. It was also found that the most important lean techniques relevant to the construction stage of building materials waste minimisation are: optimise value/value identification, good supply chain management, and visual management. Based on these findings it was concluded that the lean techniques assessed in this paper are relevant in building material waste minimisation. Adoption and implementation of the lean techniques would translate into a drastic reduction in the quantity of material waste generation in building construction projects in Nigeria.

Keywords: Building projects, Lean techniques, Material waste, Minimisation

INTRODUCTION

The construction industry plays an indispensable role in any nation's economic growth by contributing to the national Gross Domestic Product (Saidu and Shakantu, 2017)). But the industry is considered as a polluter of the environment, since construction activities contribute to environmental degradation through resource depletion, air pollution, and generation of material waste (Umar, 2019).

Construction material waste is a global problem as highlighted by Saidu and Shakantu (2017) that 10-15% of materials delivered to construction sites in the United Kingdom (UK) end up as waste; the United States (US) generates 164m tonnes of construction waste annually; and China alone generates 30% of the world's municipal solid waste, with its Construction and Demolition (C&D) waste representing 40% of the country's municipal solid waste

In Nigeria, the problem of material waste remains unresolved and requiring urgent attention in the construction industry. This problem as concluded by Saidu and Shakantu (2017) and confirmed by Umar (2019) revealed that the amount of materials used significantly predicts the quantity of material waste in building projects in Nigeria. Thus, for every 100 houses built in Nigeria, there is sufficient waste material to build another 10 houses (Ameh and Itodo, 2013)

and this depicting that 10% of materials delivered to building construction sites end up as waste (Osmani, 2011; Saidu, 2016). Hence, Babatunde (2012) emphasised that the problem of construction material waste is well known in Nigeria, but seems not to be given the recognised attention it deserves and thus, building construction sector is often classified at the bottom of the ranking of reports regarding the efficiency of the production management techniques (Bajjou *e t al.*, 2019).

The lean construction concept has been viewed to have more impact in materials waste management than other alternatives which focus on individual process and productivity improvements (Anvari *et al.*, 2011; Ogunbiyi, 2013). Lean production philosophy which was developed by the Toyota production system has been successful in achieving maximum profits and value for money to customers (More *et al.,* 2016). Adoption of the lean technique in the construction industry became necessary because of the needs to meeting project objectives (cost, quality and timely completion); the need to reduce uncertainty and waste in the production process, by adding value to construction activities; and the need of meeting clients' needs (Sorooshian, 2014; Arditi, 2016; Ansah, 2016; Kokate and Darade, 2018).

Lean approach has made a tremendous achievement in construction project performance of developed nations, such as USA, the UK, Demark and Australia; and some developing nations to include Brazil, Hong Kong, Malaysia and China (Ballard and Howell, 2003). Lean construction philosophy considers construction materials waste as potential threat that hinders flow of value to the client which must be eliminated (Maru, 2015). Ansah (2016) therefore, concludes that material waste generation on construction sites can be eliminated/minimised by applying lean construction techniques in material waste management process of building projects.

The problem materials waste could be linked to the slowness of the construction sector in adapting modern techniques, like the lean thinking for waste minimisation in construction projects (Maru, 2015; Saidu and Shakantu, 2017); and little understanding of the lean techniques and its benefits in material waste minimisation (Adamu and Abdulhamid, 2017).

The main problem in this study is that of sub-optimal understanding of the construction professionals on the relevant lean techniques for building material waste minimisation in Nigeria (Adamu and Abdulhamid, 2017).

Literature on lean construction are mostly foreign based and did not provide clear indication or worked specifically on lean techniques as they affect material waste minimisation in building projects precisely in Abuja, Nigeria (Ballard and Howell, 2003; Maru, 2015; Kokate and Darade, 2018). Thus, this study assesses the lean techniques application at stages of material waste minimisation in building construction projects in Abuja, with a view to kerbing the endemic problems of material waste in building construction projects in Nigeria.

LEAN TECHNIQUES RELEVANT TO BUILDING CONSTRUCTION PROJECTS

Bashir (2013) asserts that lean construction techniques are the different features or practices adopted in applying a Lean construction tool. In other words, Lean techniques are subsets of lean construction tools. A Lean construction tool comprise of one, two or more Lean techniques.

Last planner system

Last Planner System (LPS) aims to change the focus of control from the workers to the flow of work better assignments to direct works through continuous learning and corrective action, and to cause the work to flow across production units in the best achievable sequence of rate (Aziz and Hafez, 2013). The Percent Plan Completed (PPC) is a measurement metric of the LPS showing the effectiveness of the production planning and the workflow reliability across the activities (Forbes and Ahmed, 2011). The PPC is also calculated as the number of planned activities that are accomplished divided by the total number of planned activities (Bashir, 2013). The production planning is said to be reliable when there is a positive (upward) slope between two PPC values. One of the main advantages of the Last Planner System is that it

replaces optimistic planning with realistic planning by assessing the last planners' performance based on their ability to achieve their commitments (Song *et al.*, 2008).

5S Work Organisation

The five 5S according to O'Connor and Swain (2013) is classified as follows:

i. **Seiri (Sort):** Sorting of things should be done on the basis of its frequency of use; consequently, allow easy access to regularly used things.
ii. **Seiton (Set/Straighten):** Motion required for finding or obtaining an object should be minimised to reduce the waste, by providing easy access to required items.
iii. **Seiso (Shine):** A clean and tidy environment and machines will increase the satisfaction level of the workers, while decreasing waste due to a messy environment.
iv. **Seiketsu (Standardise):** Standardised procedures should be easily understandable to implement the first 3 Ss all over the workplace.
v. **Shitsuke (Sustain):** This process should be sustained through promotions, training, and control, and applied consistently in day-to-day activities.

The 5Ss are suited for a construction site to create easy access to things throughout the site and to create a safer working environment, and consequently, higher morale and worker satisfaction will be achieved through a good working environment.

Visual management (VM)

All over an organisation, VM can be used to immediately communicate unambiguous happenings, so it can be quickly understood. Construction sites are utilising VM in various forms, for instance, on board signs for hazardous or dangerous situations, and color-coding of fire extinguishers and electrical wiring etc. A lean construction environment could also utilise the following (O'Connor and Swain, 2013).

Just- In-Time (JIT)

As an example, the Just-In-Time (JIT) could be used to manage the transfer of materials to the construction site, according to which materials are required on site for immediate use in the construction process, without than wasting time putting the materials in temporary storage in a laydown or staging area until they are later required on site. At each step during the process, the main aim of JIT is to deliver timely, accurate quantities of the correct material (Sarhan, 2013). The three elements of JIT are summarised people, plant and systems (Almeida, 2002).

Daily huddle meeting

This planning change is implemented during the execution phase of the project by holding daily meetings to coordinate work activities. The huddle-up meeting is a great communication tool and can be used to address other project issues such as weather, environment, security, quality, or schedule. The huddle-up meeting provides a format to communicate coordination, quality, security, and schedule issues that must be addressed and, like safety, critical issues may require a work pause or stop work order until they are remedied; a warning may be issued for lesser events (Kumar and Rumasamy, 2013).

Bajjou *et al.* (2019) also highlighted Total Quality Management (TQM) as an important leant technique for ensuring quality in everything. Lean techniques and their principles are therefore, summarised in Table 1.

RESEARCH METHODOLOGY

The study adopted a survey design approach using quantitative data. Survey design was deemed suitable for this study because the lean techniques considered are those identified from the literature to which their applicability in construction project is to be verified in this study. Data was collected through structured questionnaire administered to respondents within Abuja, the Federal Capital Territory (FCT) of Nigeria. Abuja was selected because is one of the epicentre of construction activities in Nigeria. The population consisted of 80 active construction sites gotten from the Federation of Construction Industry (FOCI directory, 2018) that are practicing lean within Abuja. The population of 80 active construction sites were broken into sample frame constituting one each of the following respondents: Project managers; contractors; heads of waste management departments; and consultants, making a total of 320 respondents within the study area. These respondents were selected because they are the key players in the application of the lean techniques on construction sites. The total of 320 gotten from sample frame was subjected to Krejcie and Morgan Table for determining sample size at 5% limit of error and at 95% confidence level. The 320 was reduced to 175, which is the minimum sample size for this research. Therefore, a total of 189 questionnaires were retrieved out of the 320 distributed. 183 were found valid for the analysis, as five (5) were deemed invalid, because of poor responses. The 183 represents an effective response rate of 96.83% and this was considered suitable for analysis (Alreck and Settle, 1985).

Table 1: Lean construction Techniques and Principles

S/N	Lean Principle	Techniques
1	Customer Focus	Customer Relationship
		Customer Involvement
		Flexible Resources
		Optimise value/Value identification
2	Continuous improvement	Metrics (Productivity, Quality, Safety)
		Organisational Learning
		Huddle Meting
3	Supply	Supply Chain Management (SCM)
		Just in Time
		Pull system
4	Waste Elimination	Reduce process cycle time
		Value stream mapping
		Waste disposal management
5	People Involvement	Workforce/Workers involvement
		Top management/Contractor involvement
		Training development
		Organizational commitment
6	Planning and Scheduling	Last Planner System
		Percent Plan complete indicator (PPC)
		Collaborative planning
7	Quality	Total Quality Management (TQM)
		Root cause analysis (Pareto, 5 why's)
		Health- safety improvement
8	Standardisation	Optimise work content
		Defined work process
		Work sequences
9	Transparency	Visual Management
		Work place organization
		Building information Modelling (BIM)

Source: Bajjou *et al.* (2019).

This study adopted purposive or judgemental sampling technique, in order to select those construction sites that have acquire experience in applying lean techniques in material waste minimisation on construction site. Thus, not all construction sites were visited.

A multi-choice type questionnaire was designed for this research. The questionnaires were structured in a manner that allows respondents to select from the answer choices provided. The questionnaire reflects the major areas of the study interest, thereby, providing information relevant to the study objectives and answering the research questions.

The questionnaire asked questions on a 5-point Likert scale and divided into two (2) main parts. Part A - is related to demographic information of the respondents and their companies. Part B- asked questions about lean techniques relevant to stages of materials waste minimisation in building project.

In order to achieve the aim of this research, the descriptive method of analysing data was employed and this included the use of percentile, Mean Item Score (MIS), and Relative Importance Index (RII). Data processing was done with the aid of Statistical Package for the Social Sciences (SPSS 23) software version.

RESULTS AND DISCUSSION

Demographic information of the respondents

Result in Table 2 shows that the most represented gender are the Males with 76.50% while the Females represent 23.50%. A larger percent of the respondents have from 11 to 15 (48.09%) years of working experience.

Table 2: Demographic information of the respondents

Category	Classification	Frequency	Percentage
Gender	Male	140	76.50%
	Female	43	23.50%
	TOTAL	**183**	**100.00%**
Years of experience	1 - 5 years	31	16.93%
	6 - 10 years	43	23.50%
	11 - 15 years	88	48.09%
	15 years and above	21	11.48%
	TOTAL	**183**	**100.00%**
Academic Qualification	OND	13	7.10%
	HND	49	26.78%
	Bachelor Degree	79	43.17%
	Master degree	37	20.22%
	PhD	5	2.73%
	TOTAL	**183**	**100.00%**
Contract Value	1 – 10 Million	23	12.56%
	11 – 50 Million	44	24.04%
	51 – 100 Million	68	37.16%
	101 – 500 Million	28	15.300%
	500 – 1 Billion	20	10.93%
	TOTAL	**183**	**100.00%**
Experience with lean construction	Not aware of it at all	2	1.09%
	Just aware of it	3	1.64%
	Have been involved in its application	175	95.63%
	TOTAL	**183**	**100.00%**

Source: Researcher's analysis (2019).

The average years of working experience is calculated at 12 years. This implies that these respondents have considerable numbers of years within the built environment, hence, should be able to give response to the research questions based on experience

Academically, most of these respondents have Bachelor of Science/Technology degree (43.17%) and Higher National Diploma holders (26.78%) respectively. These result implies that the respondents for this study are academic and professionally qualified to give answers to the questions of this research.

The highest range of the contract sum handled by most of the respondents is 51-100 Million (37.16%). This shows that most of the respondent have handled construction projects involving significant sums, hence their response to the research questions can be relied upon.

The analysis also shows that 95.63% of the respondents had been involved in lean application in the building projects, while only 1.09% are not aware of it.

It can therefore be deduced that the population for the study are well equipped academically and have the requisite experience to give reasonable insight on the subject of this study.

Lean techniques relevant to pre-construction stage of materials waste minimisation in building projects

Table 3 indicates that the major lean techniques relevant to planning phase of material waste minimisation by the respondents are: Total Quality Management; visual management; optimising value/value identification; waste disposal management; reducing process cycle time; and supply chain management, with RII values of 0.81, 0.81, and 0.80s respectively. This confirms the result of Kumar and Bajjou *et al.* (2019) that the most important lean techniques at the planning stage of construction process is the Total Quality Management.

At design phase, from Table 3, the relevant lean techniques commonly applied in building construction projects by the respondents are: optimising work content; optimising product system; and defined work process, with RII values of 0.83, 0.82 and 0.80 respectively.

This confirms the study of Adamu and Abdulhamid (2016), who established that before the implementation of lean, workers often stopped work due to lack of materials. This is due to wrong information on request for materials.

Moreover, at the estimating stage of materials waste minimisation, the relevant lean techniques by the respondents are: value stream mapping and root cause analysis (Pareto, 5 whys) each with RII values of 0.80. However, training and development, error proofing and supplier involvement, were deemed to be the least techniques relevant in the estimating stage of building construction projects because they had RII of 0.60, 0.62 and 0.63 respectively.

On the overall, the lean techniques relevant to the pre-construction stage of building projects are: visual management; waste disposal management; space utilisation management were all ranked first with average RII values of 0.78. They were considered by the respondents as the key lean techniques at the preconstruction stage of building project.

However, among the least ranked techniques at the overall pre-construction stage includes; organisational learning, organisational commitment, and training and development, each with RII of 0.64, 0.66 and 0.68 respectively.

Lean techniques relevant to construction stages of material waste minimisation in building projects

Table 4 indicates that the major lean techniques at material procurement phase are: ensuring Total Quality Management; supply chain management; optimising value/value identification, visual management, with RII values of 0.81, 0.80, and 0.80s respectively.

Table 4 also reveals that, the most important lean techniques relevant to the construction stage of material waste minimisation are: Building Information Modelling; Total Quality

Management; waste disposal management and supply chain management with RII values of 0.83, 0.81 and 0.80s respectively.

The most ranked techniques for the site management phase of building construction projects are: Takt time; quick response to defect; waste awareness, and optimising value/value identification with RII of 0.89, 0.87 and 0.85 respectively.

Table 3: Lean techniques relevant to the pre-construction stage of building project

	Lean Principle/Techniques	**Planning phase**		**Design phase**		**Estimating phase**		**Overall average**	
A	**Customer Focus**	**RII**	**Rnk**	**RII**	**Rnk**	**RII**	**Rnk**	**RII**	**Rnkg**
AC1	Customer Relationship	0.77	8	0.71	14	0.64	27	0.71	20
AC2	Customer Involvement	0.73	29	0.68	21	0.71	15	0.71	20
AC3	Flexible resources	0.71	37	0.62	29	0.78	4	0.71	20
AC4	Optimise value/value identification	0.80	3	0.63	26	0.77	6	0.73	13
B	**Continuous Improvement**								
CI1	Metrics (Productivity, Quality, Safety)	0.76	9	0.53	34	0.75	11	0.68	32
CI2	Organisational learning	0.75	19	0.55	33	0.63	30	0.64	38
CI3	First run studies	0.75	19	0.60	31	0.68	20	0.68	32
CI4	Huddle meting	0.75	19	0.78	7	0.76	6	0.76	7
C	**Supply of material**								
S1	Supply Chain Management (SCM)	0.80	3	0.74	11	0.76	6	0.77	4
S2	Just in Time	0.75	19	0.69	20	0.69	17	0.71	20
S3	Supply involvement	0.73	29	0.72	14	0.62	33	0.69	28
S4	Supplier development	0.72	34	0.72	14	0.76	6	0.73	13
D	**Waste Elimination**								
WE1	Reduce process cycle time	0.80	3	0.71	16	0.70	16	0.74	11
WE2	Waste awareness and consciousness	0.76	9	0.73	12	0.75	11	0.75	9
WE3	Value stream mapping	0.76	9	0.73	12	0.80	1	0.77	4
WE4	Space utilisation	0.76	9	0.78	7	0.79	3	0.78	1
WE5	Optimize Product system	0.74	25	0.82	2	0.76	6	0.77	4
WE6	Waste disposal management	0.80	3	0.79	4	0.76	6	0.78	1
E	**People Involvement**								
PI1	Workforce/Workers involvement	0.76	9	0.78	7	0.68	20	0.74	11
PI2	Top management involvement	0.73	29	0.79	4	0.68	20	0.73	13
PI3	Training development	0.73	29	0.71	16	0.60	35	0.68	32
PI4	Team Work	0.79	6	0.70	19	0.64	27	0.71	20
PI5	Organizational commitment	0.74	25	0.59	32	0.65	26	0.66	36
F	**Planning & Scheduling**								
PS1	Last Planner System	0.76	9	0.63	26	0.68	20	0.69	28
PS2	Percent Plan complete indicator	0.75	19	0.67	25	0.68	20	0.70	26
PS3	Collaborative planning	0.74	25	0.70	19	0.67	25	0.70	26
G	**Quality of material**								
Q1	Total Quality Management (TQM)	0.81	1	0.71	16	0.66	25	0.73	13
Q2	Error proofing Poka-yoke	0.76	9	0.68	21	0.62	33	0.69	28
Q3	Response to defect	0.72	34	0.68	21	0.68	19	0.69	28
Q4	Root cause analysis (Pareto, 5 why's)	0.71	37	0.63	26	0.80	1	0.71	20
Q5	Fail Safe for quality	0.79	6	0.67	25	0.78	4	0.75	9
H	**Standardisation of Processes**								
ST1	Optimise work content	0.76	9	0.83	1	0.69	17	0.76	7
ST2	Defined work process	0.76	9	0.80	3	0.64	27	0.73	13
ST3	Takt time	0.74	25	0.68	21	0.74	13	0.72	18
I	**Transparency in Management**								
T1	Visual Management	0.81	1	0.78	7	0.74	13	0.78	1
T2	Work place organization	0.58	38	0.71	16	0.63	30	0.64	38
T3	Building information Modelling (BIM)	0.73	29	0.79	4	0.63	30	0.72	18

Source: Researcher's Field Survey (2019).

The most important lean techniques relevant to the construction stage of building materials waste minimisation as shown in Table 4 are: optimise value/value identification, supply chain management, visual management and building information modelling with the most RII.

Table 4: Lean techniques relevant to the construction stage of building project

	Lean Principle/Techniques	**Material Procurement**		**Construction Management**		**Site Management**		**Overall average**	
A	**Customer Focus**	**RII**	**Rnk**	**RII**	**Rnk**	**RII**	**Rkn**	**RII**	**Rnk**
AC1	Customer Relationship	0.78	7	0.77	10	0.78	17	0.78	10
AC2	Customer Involvement	0.72	33	0.72	32	0.66	33	0.70	33
AC3	Flexible Resources	0.71	37	0.70	36	0.74	27	0.72	32
AC4	Optimise/ identification of value	0.80	2	0.79	6	0.85	3	0.81	1
B	**Continuous Improvement**								
CI1	Metrics (Productivity and Quality)	0.75	17	0.76	12	0.78	17	0.76	17
CI2	Organizational Learning	0.74	23	0.74	23	0.75	26	0.74	25
CI3	First Run Studies	0.74	23	0.73	28	0.68	32	0.72	32
CI4	Huddle Meting	0.75	17	0.75	19	0.78	17	0.76	17
C	**Supply of material**								
S1	Supply Chain Management	0.80	2	0.80	3	0.84	6	0.81	1
S2	Just in Time	0.75	17	0.74	23	0.79	13	0.76	17
S3	Supply Involvement	0.73	29	0.73	28	0.76	24	0.74	25
S4	Supplier Development	0.72	33	0.71	35	0.67	33	0.70	33
D	**Waste Elimination**								
WE1	Reduce process cycle time	0.79	5	0.79	6	0.76	24	0.78	10
WE2	Waste consciousness awareness	0.76	11	0.76	12	0.85	3	0.79	5
WE3	Value stream mapping	0.76	11	0.77	10	0.77	23	0.77	13
WE4	Space Utilization	0.75	17	0.75	19	0.81	9	0.77	3
WE5	Optimize Product system	0.74	23	0.74	23	0.69	31	0.73	31
WE6	Waste disposal management	0.79	5	0.80	3	0.78	17	0.79	5
E	**People Involvement**								
PI1	Workforce/Workers involvement	0.76	11	0.76	12	0.84	6	0.79	5
PI2	Top management involvement	0.74	23	0.73	28	0.78	17	0.75	23
PI3	Training development	0.73	29	0.73	28	0.78	17	0.74	25
PI4	Team Work	0.78	7	0.78	8	0.70	31	0.75	23
PI5	Organizational commitment	0.73	29	0.72	32	0.78	17	0.74	25
F	**Planning & Scheduling**								
PS1	Last Planner System	0.76	11	0.76	12	0.85	3	0.79	5
PS2	Percent Plan complete indicator	0.75	17	0.75	19	0.82	8	0.77	14
PS3	Collaborative planning	0.74	23	0.75	19	0.80	10	0.76	17
G	**Quality of material**								
Q1	Total Quality Management	0.81	1	0.81	2	0.72	29	0.78	10
Q2	Error proofing Poka-yoke	0.76	11	0.76	12	0.79	13	0.77	13
Q3	Response to defect	0.72	33	0.72	32	0.87	2	0.77	13
Q4	Root cause analysis (Pareto, 5 why's)	0.72	33	0.70	36	0.80	10	0.74	25
Q5	Fail Safe for quality	0.78	7	0.78	8	0.81	9	0.79	5
H	**Standardization of Processes**								
ST1	Optimize work content	0.76	11	0.76	12	0.71	30	0.74	25
ST2	Defined work process	0.75	17	0.76	12	0.79	13	0.76	17
ST3	Takt time	0.73	29	0.74	23	0.89	1	0.79	5
ST4	Work sequences	0.74	23	0.74	23	0.80	10	0.76	17
I	**Transparency in Management**								
T1	Visual Management	0.80	2	0.80	3	0.79	13	0.80	3
T2	Work place organization	0.63	38	0.61	37	0.67	32	0.63	35
T3	Building information Modelling	0.77	10	0.83	1	0.79	13	0.80	3

Source: Researcher's Field Survey (2019).

These confirms the study of Small *et al.,* 2011 who described how to incorporate the key concepts of lean techniques in the construction process and explains the interaction of key concepts in regards to the construction process.

According to the study, pre-construction and construction stages are the best time to synergize the LC concepts. Both of these stages are crucial due to determination of material, equipment and labour during pre-construction and elimination of construction waste during construction

CONCLUSION AND RECOMMENDATIONS

Lean construction techniques have been known globally as production system with a high capacity of waste minimisation. This paper addressed the problem of sub-optimal understanding of the construction professionals on the relevant lean techniques for building material waste minimisation in Nigeria. Thus, this paper assessed lean techniques for material waste minimisation in building projects in Abuja, Nigeria. The study concludes that the major lean techniques relevant to building material waste minimisation are: Total Quality Management; visual management; optimising value/value identification; waste disposal management; supply chain management; visual management reducing process cycle time; and adoption of good supply chain management.

Based on this conclusion, it can be recommended that effective application of these lean techniques would translate into a drastic reduction in the quantity of material waste generation in building construction projects in Nigeria.

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Evaluation of the Significance of Timber as a Source of Sustainable Building Material in Owerri, Nigeria

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Abstract:
In Nigeria, timber as sustainable building material is found in large quantities and varieties. As a construction material, it has come to drive the advancement of the construction process. Based on various purposes of timber utilization in building projects, timber usage in building can be classified as structural, functional and decorative/aesthetics. It possesses qualities that have made it a material of choice in millennia. The study highlights the importance of timber as a sustainable building material for residential buildings. The study was carried out in Owerri, the capital city of Imo State and a qualitative research method was adopted which involves the professionals in the construction industry who are currently involved in construction projects. A Total of 250 structured questionnaires were administered using the stratified random sampling methods, whereby 240 questionnaires were returned. The data collected was analysed using descriptive methods. The result shows that 69.3% *of all the sampled professionals strongly agree that timber is very valuable and a sustainable building material for residential building. The study recommends timber as an essential building material that is very versatile, renewable and can be useful in all building types. Therefore, the use of timber should be highly encouraged in the building industry to maintain its functionality and durability in building industry.*

Keywords: Aesthetics, Construction, Residential buildings, Sustainable material, Timber.

INTRODUCTION

Timber is the hard fibrous substance consisting basically of xylem that makes up the greater part of the stems, branches, and roots of trees or shrubs beneath the bark and is found to a limited extent in herbaceous plants (Amal & Halil, 2017). Timber is one of the components of housing which is among the most important basic human needs for shelter. It has been used in construction for thousands of years and is still one of the most widely used building materials. Certain properties of timber can be complex in terms of its use in construction, but despite this, engineers have successfully harnessed this natural resource to build a variety of structures. It is a vital component towards a sustainable environmental development. Sustainability has been characterized as a development of the economy that satisfies the needs of the current generation without compromising the opportunity and the potential the future generations (Amal & Halil, 2017). This study provides a wider perspective of timber as one of the main sustainable building materials used in construction. Generally, sustainability is divided into three sectors, which includes economic, environmental, and social sectors, which represent three pillars of sustainable development (Wacker, 2010). In design, sustainable construction affects the short and long term economic goals (Amal & Halil, 2017).

Timber is the ultimate renewable material and a fibrous rigid material of plant origin (Abimaje *et al*., 2014). The unique advantages of this material, its widespread availability, sustainable renewal, favourable ecological assessment and flexibility of implementation grant it valuable in the eyes of scientists and engineers. In the eyes of architects, however, the simplicity and beauty of timber as a new aesthetic are not only a visual experience - architects try to get its smell, texture and tangibility and integrate them into the architectural built environment (Obucina *et al., 2017*). Timber is generally classified into hardwood and soft wood. Hard wood is heavier and denser than soft wood and is mainly use for the construction of walls ceiling and floors. Softwoods are generally used to make more of the inner structures to the frame of hardwood, such as doors and window frames. It is also used to produce furniture (Heritage Builders Ltd, 2017). **Softwood** is a type of wood that is cut from trees belonging to

gymnosperms, such as coniferous trees. By contrast, hardwood typically comes from angiosperm, deciduous and broad-leaved trees.

LITERATURE REVIEW

Timber is one of the longest standing building materials in existence, with evidence showing homes built over 10,000 years ago used timber as a primary source for construction materials. Europe's Neolithic long house--a long, narrow timber dwelling built in 6000 BC-- is an excellent example (Sarah, 2016). As one of the largest buildings during that period, the Neolithic long house was solid and massive, with a capacity of housing around 30 people. Since then, the discovery of different elements such as bronze and steel have changed and improved the way timber is applied to building construction. Timber continues to be used to create both modest buildings such as the log cabin, and impressive structures such as Chinese temples. Boasting it's environmentally friendly, renewable and extremely durable features, wood remains an extremely popular choice for both buildings and furnishings (Sarah, 2016).

Timber has been used as a building material for thousands of years, being second only to stone in terms of its rich and storied history in the world of construction. In addition, no high-energy fossil fuels are required to produce wood, unlike other common building materials such as brick, steel or plastic (Falk, 2009). The chemical properties of timber are inherently complex, but even in spite of this challenge; human beings have successfully harnessed the unique characteristics of timber to build a seemingly unlimited variety of structure. This unique versatile material is commonly used to build houses, shelters, boats and many more, but it is also extensively used in furniture and home decoration industry as well. Perhaps one of the biggest advantages of using timber as a building material is that it is a natural resource, making it readily available and economically feasible. It is remarkably strong in relation to its weight, and it provides good insulation from cold. Timber can be fabricated into all kinds of shapes and sizes to fit practically any construction need (Falk, 2009). It is also the perfect example of an environmentally sustainable product; it is biodegradable renewable and carries the lowest carbon footprint of any comparable building material.

History of timber in building construction

Right from the dawn of man, timber was used as a construction material to build structures like shelter. Man had to seek protection from predators and harsh weather conditions using protective cover that usually comprised of dugouts, caves, reeds, twigs, wood, mud, stone and snow. It is proposed that the first primitive structure was invented when early man pulled down a tree branch with full foliage (Guilhemjouan, 2013). The use of timber in construction dates back to 500 to 100 B.C. Timber was spatially used in roof constructions by the ancient Roman and Egyptian civilizations that majorly used stone in buildings. Most noteworthy during the period is the development of the ten and mortise joints in timber framing. Over the subsequent thousand years in Europe, the use of timber frames heightened in areas with vast timber resources. Primitive construction techniques were employed and as a means of foundation, timber was either driven or laid onto the ground. Timbers were tied together using primitive rope of animal hides. Advanced joinery techniques were developed to build more permanent and decent houses using timber frames. Stone foundations provided superior support for the houses, and prevented rapid deterioration of the structural posts. Timber frames were permanently fastened using joinery techniques. In Europe, modern timber framing was developed in the 9th and 10th centuries and is characterized by exceptional building skills (BRTW, 2017). Timber framing techniques would later evolve across Asia, Africa and the undiscovered Americas.

Seasoned timber as a sustainable construction material

Seasoning of timber is the process by which moisture content in the timber is reduced to a required level. By this process, the strength, elasticity and durability properties are developed thus making it a sustainable material. As a sustainable material, it has many benefits like thermal and acoustic insulation, availability and adaptability, structural stability, easy of manufacturing, fire resistance, aesthetic qualities, cost effectiveness and low thermal conductivity (Falk, 2009). Wood structures require less energy to build and to operate, which reduces our reliance on fossil fuels. Wood can be recycled and renewed, again and again and only few other materials can match the unique combination of benefits; strength, affordability and environmental sustainability of wood (Abimaje *et al*., 2014).

According to Okereke (2006), a sustainable material should possess the following characteristics:

i. Easily available and affordable, preferably locally

ii. Meets with the requirements as specified in National Standards; in terms of durability and maintainability

iii. Should be environmental friendly and should not constitute any health hazard;

iv. Should be versatile in usage, that is, it could be used for different purposes (as walling materials, flooring, etc). It is obvious that timber has these qualities of a sustainable building material.

The sustainability of timber can also be determined by comparing its impact on the environment with three other common building materials in terms of fossils emission, carbon dioxide emission and thermal conductivity as presented by (Abimaje *et al*., 2014). Rough sawn timber uses 750 MJ/m3, steel uses 266000 MJ/m3, concrete uses 4800 MJ/ m3 and aluminium uses 1,100,000 MJ/m3 of fossil fuel. Burnt fossil fuel emits greenhouse gases such as carbon monoxide, sulphur dioxide and methane into the atmosphere (Abimaje *et al*., 2014). These gases have negative impact on the environment. Timber requires less fossil fuel to manufacture than steel, concrete and aluminum therefore is more sustainable and environmental friendly. In the aspect of carbon dioxide emission, rough sawn timber releases 30 Kg/t of Carbon dioxide, while steel, concrete and Aluminium release 700Kg/t,50 Kg/t and 8700 Kg/t respectively. It also shows that rough sawn timber stores 250 Kg/m3 of Carbon dioxide while steel, concrete and aluminium do not store any. It obvious that timber releases the least and stores the highest amount of carbon dioxide during its manufacture, hence it releases less greenhouse gases into the atmosphere (Abimaje *et al*., 2014). Also in the aspect of thermal conductivity of some building materials, it shows that Fired clay has 1.0 J/m-IK -I , cement board 0.6 J/m-I k -I , limestone gravel 0.6 J/m-I k -I , concrete 1.4-2.9 J/m-IK -I , stone 1.5- 3.0 J/m-IK -I , wood 0.05-0.0.15 J/m-I k -I and steel 19.0-21.0J/m-I k –I (John, 2003). This made it clear that timber require less insulation to retain their warmth. This will be a great need to tropical regions that has excess heat gain in buildings built with concrete and steel. The use of timber will promote energy saving in cooling houses. The use of timber is classified into aesthetics, functional and structural purposes. Table 1 gives classification of various wood species in building project as well as their purpose of use.

Table 1 and Figure 1 show the purpose of various woods in building construction. It shows that some timber like afara, pine, oak, redwood, omo performs all the functions (use for functional, aesthetics and structural purposes) while some timber perform dual function, some also performs only single function as being a good structural material

Table 1: Classification and Purpose of use of various wood species in building projects

Local Name	Botanical Name	Purpose of use		
		Aesthetics	Functional	Structural
Mohagamy	khayaivorensis	—	✓	✓
Iroko	melicea excels	—	✓	✓
Ayin	anogeissusleicarpus	—	—	✓
Teak	tectonagrandis	—	✓	✓
Opepe	naucleadiderrichii	—	✓	✓
Araba	ceibapentandra	—	—	✓
Oak	quercus borealis	✓	✓	✓
Afara	terminaliaivorensis	✓	✓	✓
Omo	cordial millenii	✓	✓	✓
Pine, red	pinusresinosa	✓	✓	✓
Apa	afzeliaafricana	—	—	✓
Apado	conluuoagrandiflora	—	—	✓
Arere	triplochitonacleroxylon	—	—	✓
Aspen	populustremuloides	—	—	✓
Redwood	sequoia sempervirens	✓	✓	✓
Agbonyin	piptadeniastrumafricanum	✓	—	✓

✓ Means "Used for", — means "Not used for".

Source: Adesogan, (2013)

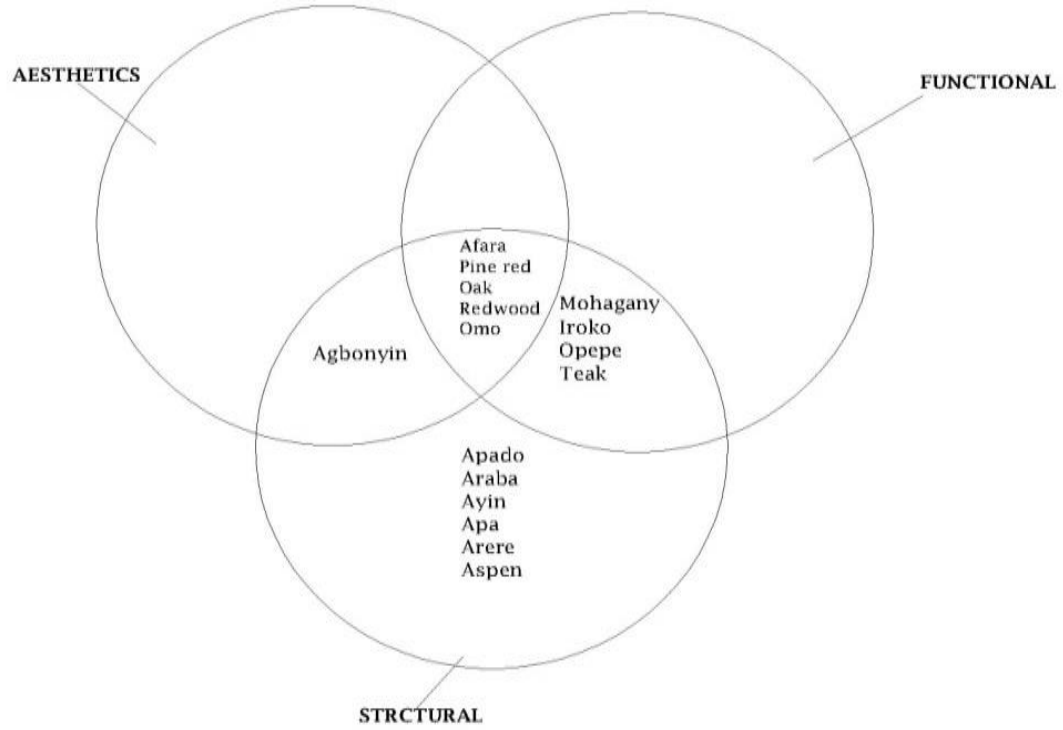

Figure 1: Diagram shows the purpose of various woods in building construction.

Source: Adesogan, (2013)

.STUDY METHODOLOGY

The study was carried out in Owerri – the capital city of Imo State in Nigeria. It is also the State's largest city, followed by Orlu and Okigwe as second and third respectively. Owerri consists of three Local Government Areas which include Owerri Municipal, Owerri North, and Owerri West. It is an urban area with high level of building construction. The data was collected by the use of structured questionnaire distributed to the professionals in building industry to evaluate the use and need of wood as a sustainable material with particular reference to residential buildings. A total of 250 respondents were involved in the study. The questionnaires was structured on the sustainability of wood based on the following; (i) Structurally strong, (ii) Natural insulator (iii) Durability (iv) cost effectiveness (v) Aesthetics (vi) Employment (vii) Fast and efficient to build with. The class of each structured questionnaire was determined using the following score as below: SA= strongly agree, A= Agree, U= Uncertain, D= Disagree, SD= strongly disagree. Table 2 shows determination of the population of the study. The questionnaires were distributed among the following professionals in the State such as Civil Engineers, Architects, Quantity Surveyors, Builders and Artisans. The population was chosen on the registered professionals from their respective professional bodies.

Table 2: Determination of the population of study area

Respondents	Owerri Municipal	SSOM	Owerri North	SSON	Owerri West	SSOW	Total Population
Civil Engineers	12	12	15	14	17	16	44
Architects	28	26	22	21	16	15	66
Quantity Surveyors	15	14	19	18	11	12	45
Builders	10	10	17	16	11	12	38
Artisans	21	20	17	16	19	18	57
Total	86	82	90	85	74	73	250

Key Notes: SSOM= Sample size for Owerri Municipal, SSON= Sample size for Owerri North, SSOW= Sample size for Owerri West.

Source: Researchers' fieldwork, (2019).

In Table 2, a total population of 44 Civil engineers, 66 Architects, 45 Quantity surveyors, 38 builders and 57 Artisans were determined amounting to sample size of 250. The population was chosen based on the registered professionals from their respective professional bodies. Table 3 shows sample size distribution for the three L.G.A in Owerri, Nigeria.

Table 3: Sample Size distribution and calculation for the three L.G.A in Owerri, Nigeria

Respondents	Total Population	PTP	Sample Size	NOQA	NOQR	PQR
Civil Engineers	44	18	40	44	42	17
Architects	66	26	55	66	64	29
Quantity Surveyors	45	18	40	45	44	13
Builders	38	15	35	38	35	17
Artisans	57	23	50	57	55	24
Total	250	100	220	250	240	100

Key notes: PTP = % of Total Population, NOQA= No of questionnaire administered, NOQR= No of questionnaires Returned, PQR= % of questionnaires returned.

Source: Researchers' fieldwork, (2019).

The Table 3 above shows sample size distribution for the professionals. The percent of sample size distribution of Civil engineers was 18%, the Architects =26%, Quantity surveyors=18%, Builders=15%, Artisans =23%, and it was distributed proportionally across the five mentioned professionals in the study area. During the field work 250 questionnaires were distributed among the five professionals according to the proportion of sample size found in each Local Government area. A total of 240 questionnaires were returned.

RESULTS AND DISCUSSION

Based on the need for seasoned woods and its level of importance as a construction material, Figure 2 explains the need and the sustainability of timber in construction by the respondents. The level of importance is scored by 50%. The total of 240 questionnaires was returned, 49 respondents believe in its structurally strength, 36 respondents believe in its natural insulator, 45 respondents believe in its durability, 13 respondents believe in its cost effectiveness, 37 respondents believe in its aesthetic value, 23 respondents believe in its employment features, 30 respondents believe in its fast and efficient to build with. The information is demonstrated on the table below.

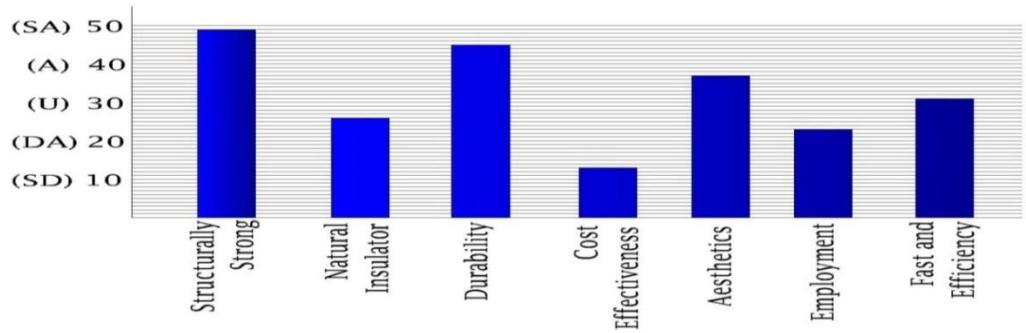

Figure 2: Sustainability of wood in building industry based on the respondents.
Source: Researchers' fieldwork, (2019).

Figure 3 shows the number of respondents on the need of wood in construction industry. The result shows that 18% of Civil Engineers, 27% of architects, 23% of Artisans, 18% of quantity survey, 14% of builders believe that wood has a great value and is well needed in building industry.

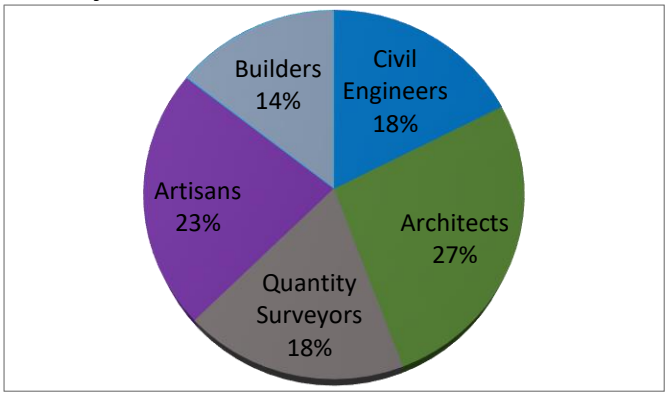

Figure 3: Shows the degrees of the respondents based on the need of wood in building and construction industry.
Source: Researchers' fieldwork, (2019).

The number of respondents was gotten based on the number of returned questionnaires. A total of 240 retuned questionnaires were used for the analysis. The analysis is illustrated in the pie chart diagram

Table 4: Questions asked to respondents to ascertain the use of wood.

OUESTIONS	SA	A	D	SD	Total
Timber acts as a structural material.	182	51	7	0	240
Timber is durable in construction	154	64	15	7	240
Timber has high Aesthetics value	171	49	9	11	240
Timber creates an avenue for employment	185	30	16	9	240
Timber is efficient and fast to build with	151	59	18	12	240
Timber acts as a natural insulator	152	68	17	3	240
Timber is cost effective to build with	169	44	19	8	240
Sub- Total	1164	365	101	50	1680
Total Percentage (%)	69.30%	21.70%	6.00%	2.90%	100%

Key notes: SA = Strongly Agree, A = Agree, D = Disagree, SD = Strongly Disagree
Source: Researchers' fieldwork, (2019).

Table 4 shows some questions asked by the respondents to know the need of wood in building industry. The number of respondents used was the number of returned questionnaire. 240 was the actual number of questionnaires returned and it was used to determine the values. The questions were asked to know the number of people that strongly agree that wood is really a valuable material in building industry. The question is rated on the table above. The result shows that 69.3% strongly agree that wood acts as a valuable material based on the responded questions. The questions were also subjected to 5 point likert scale for assessment shown in Table 5.

Table 5: Respondents' Consensus Opinion in determining the use and importance of Timber

S/N	Survey Statement	Respondents' Ranking				∑F	∑FX Sum	Mean Score	RII	RANK	Consensus Opinion
		SD	D	A	SA						
		1	2	3	4						
1	Timber acts as a natural insulator/structural material	0	7	51	182	240	895	3.73	0.746	1st	Strongly Agree
2	Timber is durable in construction	7	15	64	154	240	845	3.52	0.704	6th	Strongly Agree
3	Timber has high Aesthetics value	11	9	49	171	240	860	3.58	0.716	3rd	Strongly Agree
4	Timber creates an avenue for employment	9	16	30	185	240	871	3.62	0.725	2nd	Strongly Agree
5	Timber is efficient and fast to build with	12	18	59	151	240	829	3.45	0.69	7th	Strongly Agree
6	Timber acts as a natural insulator	3	17	68	152	240	849	3.53	0.708	5th	Strongly Agree
7	Timber cost effective to build with	8	19	44	169	240	854	3.55	0.712	4th	Strongly Agree

Mean ranges: 1- 1.75 = Strongly Disagree, 1.76 – 2.50 = Disagree, 2.51- 3.25 = Agree and 3.26 – 4.00 = Strongly Agree. **Source:** Researchers' fieldwork, (2019).

Table 5 shows Respondents' Consensus Opinion in determining the use and importance of Timber. The respondents strongly agreed that timber is highly valued and a sustainable building material. The results shows "Timber acts as a structural material" ranked 1st with mean score of 3.73 and relative index of 0.746, "Timber creates an avenue for employment" ranked 2nd with mean score of 3.62 and relative index of 0.725, "Timber has high Aesthetics value" ranked 3rd with mean score of 3.58 and relative index of 0.716, "Timber cost effective to build with" ranked 4th with mean score of 3.55 and relative index of 0.712, "Timber acts as a natural insulator" ranked 5th with mean score of 3.53 and relative index of 0.708, "Timber is durable in Construction" ranked 6th with mean score of 3.52 and relative index of 0.704, "Timber is efficient and fast to build with" ranked 7th with mean score of 3.45 and relative index of 0.690. This shows that the respondents strongly agree that timber is a sustainable building material.

CONCLUSION AND RECOMMENDATION

The result shows that 69.3% of the sampled professionals strongly agree that timber is very valuable and a sustainable building material for residential building. Hence in the modern building practice, timber and other wood products are extensively useful in construction as well as prefabricated standard wood cottages. It is an asset in building industry and also valued by all the professionals in the construction industry. A large quantity of wood is consumed in building and installation work for making piles, poles, scaffolds and many loads bearing functions. It is widely used for all purpose especially for structural, aesthetics and functional purposes because of its sustainability features.

This study recommends that government authorities should consider a holistic picture ranging in scale from the science of the cell wall to the engineering and global policies that could maximize forestry and timber construction as a boon to both people and the planet. This will highly promote the rate of wood usage and help to promote the economy and also aid in job creation. Also a good technical knowledge of timber is necessary for its application and its preservation to avoid biodegradation, possible failure of timber structure. Is very vital to subject timber to possible prophylactic treatments inform of seasoning and application of chemical preservatives.

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Evaluation of the Compressive Strength of Concrete Using Bush Gravel as Coarse Aggregates Partially Replaced with Broken Bricks

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Abstract:
Concrete is the most used building material in the construction industry. In recent years, concrete production has become more expensive due to the increase in demand for it, which has led to a rise in the cost of concrete production. This has compelled the construction industry to find alternatives to concrete production. In this study, the compressive strength of concrete is evaluated when bush gravel, as coarse aggregate, is partially replaced with broken bricks which have acceptable properties comparable to a normal concrete. The absolute volume method was used in determining the values of water/cement ratio, aggregate/cement ratio and the relative proportions of aggregates of various sizes. Mix ratio of 1:2:4 and water/cement ratio of 0.45% were used. The compressive strength observed after 7 days was 15.29, 14.39, 14.68, 14.55, 14.22, 13.41 and 10.75N/mm^2, while compressive strength after 14 days was 18.46, 16.12, 15.38, 15.23, 14.87, 14.82 and 13.67N/mm^2,compressive strength after 21 days was 20.45, 19.94, 19.63, 19.41, 19.26, 17.78, and 14.81N/mm^2, and finally after 28 days, the compressive strength was 23.63, 21.85, 20.30, 19.29, 18.26, 18.22 and 16.45N/mm^2 all for 0, 10, 20, 30, 40, 50, and 60% replacements of broken bricks respectively. These results clearly shows that the compressive strength of concrete increases as the curing ages increases and both bush gravel and broken bricks can be used as coarse aggregates for structural concrete when structural coarse aggregates are hard to find, and where high strength of concrete is not needed.

Keywords: Concrete, Coarse aggregates, Compressive strength, Bush gravel, Broken bricks.

1. Introduction

Concrete is one of the most versatile construction materials in-used; it consists primarily of, cement, aggregates, water and admixtures. Concretes' strength is formed as a result of hydration, and this happens when the water and cement reacts. Its product consists majorly of calcium aluminates, silicates and hydroxides which are relatively insoluble and bind the aggregates in harden mixture. Concrete is said to be stronger in compression than it is in tension and it is used to carry loads in structures of compressive nature. Steel bars are embedded in concrete structures when they are subjected to tensile stresses. Neville (1995).

According to Chong (1981), the required proportions of material for a given concrete grade are normally obtained from mix design. When the constituent's materials are properly batched and mixed thoroughly, this goes through the process of hydration and hardens into a mass of concrete which is capable of resisting compressive and tensile stresses. The compressive strength of concrete determines how well a concrete structure can resist compressive stress applied. This also depends on the quality of such concrete. Concrete constitutes about seventy five percent of aggregates; this makes its quality, types and general properties determine the quality of concrete. Amit Gupta (2004). In construction, coarse aggregates used consist of one or a combination of particles having a size of between 4.76mm and 20mm, they can be natural or machine crushed rock aggregate. Duggal (2008). Natural gravel and sand are usually dug or dredged from a pit, river, lake, or seabed. Crushed stone is produced by crushing quarry rock, boulders, cobbles, or large-size gravel. Close to half of the coarse aggregates used in Portland cement concrete are gravels; most of the remainder are crushed stones. McGennis *et al.* (1995). It is important to note that the use of waste material as aggregates in concrete production is beneficial; this is because it reduces the impact on economic cost of quarrying operations, processing and transport.

In recent times, reusing waste is desirably increased; this is due to rise in tipping fees for disposing these waste materials in landfills. Robinson *et al* (2004).). Different sustained constructive initiative developed in recent years has made reuse of construction and demolition debris (as aggregates) an alternative in carrying out different design for structures.
Materials that could be used as coarse aggregates in concrete include palm kernel shells, broken bricks, and marbles. Barra *et al* (1998). Brick products usually are made from naturally occurring materials mixed with water and formed into the desired shape, fired in a kiln to give the clay mixture a permanent bond. With the enormous amount of brick produced in the country, the material can possibly provide a unique source of aggregates which can actually be used to produce a more efficient and sustainable concrete. Desai (2004). This, in addition will reduce the waste that is usually land filled (which is detrimental to the environment).Aggregates made up of bricks is lighter than normal weight aggregate and will reduce haul cost. This goes to show that concrete made with brick aggregate is lighter than concrete made with normal aggregates thereby reducing the self weight of the concrete. This study will majorly deal on broken bricks as waste chips which can be utilized as aggregates, in addition with the bush gravel locally called Bida natural stones as the normal coarse aggregates. This research work is aimed at evaluating the strength of concrete when Bida natural stones is used as coarse aggregates and partially replaced with broken bricks at 0, 10, 20, 30, 40, 50 and 60% and cured for 7, 14, 21 and 28 days.

2. MATERIALS AND METHOD

2.1 Materials

2.1.1 Cement
The cement used in the study was OPC (Grade 42.5) produced by Dangote cement industry at Obajana plant in Nigeria. It conformed to BS EN 197-1:2011

2.1.2 Fine Aggregates
The natural sharp sand used here was extracted from a borrow pit behind the male hostel Gidan Kwano campus of the Federal University of Technology Minna. The samples collected were air dried inside the civil laboratory in order to reduce the moisture content since it was gotten from a river. Impurities were removed and it conformed to the requirements of BS EN 206 and or BS8500-1:2015/BS8500-2:2015.

2.1.3 Bush Gravel
The size of the chippings used in this research work was size 14mm to 28mm nominal size gotten from Bida town, Niger state. The aggregates were passed through a set of sieves to know their actual dimensions.

2.1.4 Broken Bricks
The size of the bricks used in this study were also of same size as the Bida gravels that is 14-28mm.The sandcrete broken bricks were gotten from a construction site near the engineering complex of the Federal University of Technology Minna.The bricks were later broken in the civil laboratory with the help of a hammer into the required sizes and set of sieves were used to ascertain their sizes.

2.1.5 Potable Water

Potable water used was obtained from the Civil Engineering Laboratory of Federal University of Technology, Minna, Niger State.

2.2 Methods

2.2.1 Concrete Mixture

The mix ratio used for the experiment was 1:2:4 (cement: fine aggregate: coarse aggregate) by weight, the water/cement ratio was 0.45. According to Ramonu *et al* (2019), mix ratio of 1:2:4 provided a minimum compressive strength of 17 N/mm^2 after while a mix ratio of 1:3:3 gave a compressive strength of 15 N/mm^2 after twenty eight days of curing. The coarse aggregate was replaced with broken bricks at 0, 10, 20, 30, 40, 50 and 60% partial replacement for bush gravel. For each replacement level, 3 specimens were prepared for the compressive strength. The average of these numbers of specimen were obtained and used for analysis. All concrete cube specimens were cured in water tank for 7, 14, 21 and 28 days respectively. Table 1 shows the concrete mix Design Summary for the Compressive Strength.

2.2.2 Sieve Analysis

Sieve Analysis was carried out to determine the particle size distribution. The sieve analysis was carried out in accordance with BS 410-1:2000

2.2.3 Specific Gravity

Specific Gravity test was performed in accordance with BS 812-2:1995

2.2.4 Bulk Density

Bulk Density and Unit Weight tests were performed in accordance with BS 812-2 and BS 1377-9:1990

2.2.5 Workability

Slump test was carried out in accordance with BS 12350-2

2.2.6 Compressive Strength

Compressive strength test was carried out in accordance with BS 1881-116:1983. A total of 84 cubes costing about fifty thousand naira were cast. For each replacement level, 3 cubes were prepared using a metallic mould of 150x150x150mm, cured and crushed and the average value of the three results was used. Mix Design for the compressive strength Test is shown in Table 1.

2.2.5 Aggregate Impact Value Test

Aggregate impact value was carried out in accordance with BS 812-112:1990

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Sieve Analysis

The result of the particle size distribution carried out in accordance with BS 410 is presented in Figure 1

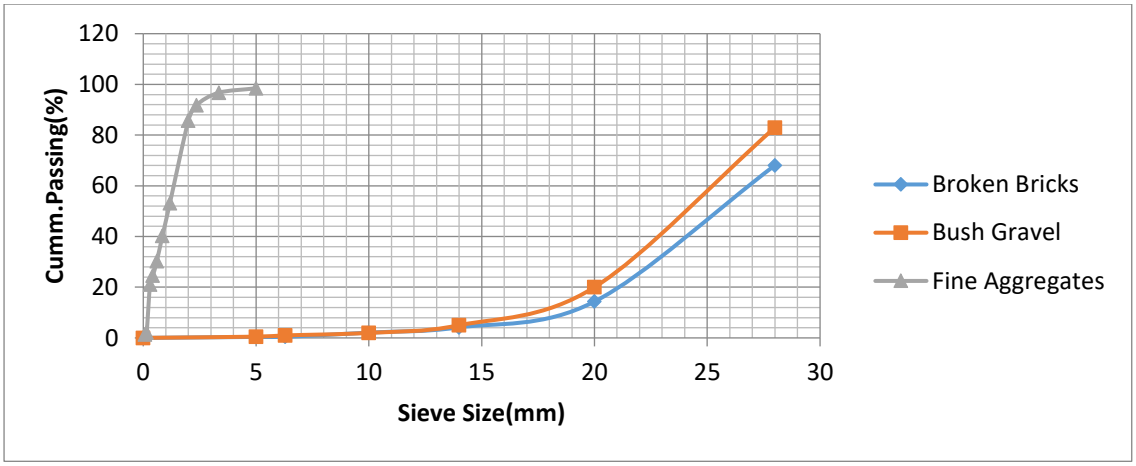

Fig 1: Sieve analysis curve for fine aggregates, bush gravel and broken bricks

Table 1: Concrete Mixes Design Summary for Compressive Strength with 6.07 litres of Water, 13.50kg of Cement and 26.99kg of Fine aggregates

Replacement (%)	Bush Gravel(Kg)	Broken Bricks(Kg)
0	0.00	53.98
10	5.40	48.58
20	10.80	43.18
30	16.19	37.39
40	21.59	32.39
50	26.99	26.99
60	32.39	21.59

3.1.3 Properties of Aggregates

Table 2 shows the values of the properties of the various aggregates.

Table 2: Properties of Aggregates

Property	Fine Aggregate	Bush Gravel	Broken Bricks
Specific Gravity	2.63	2.70	2.33
Bulk Density(Kg/m^3)	1656.86	1709.80	1075.41
Water Absorption (%)	6.30	2.40	4.44
Aggregate Impact Value (%)	-	27.11	29.60

3.1.4 Workability

The slump test result is shown in Figure 2.

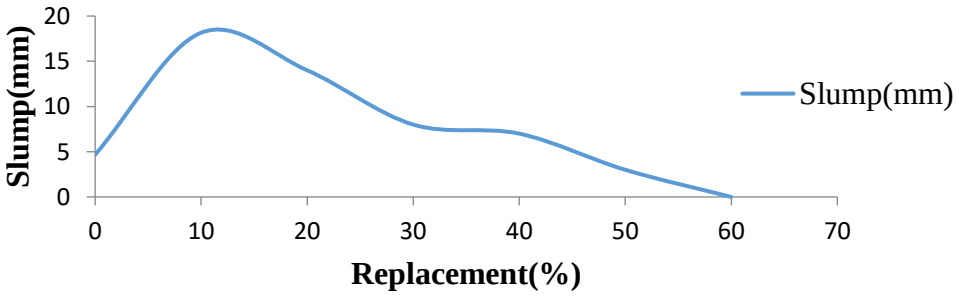

Fig 2: Variation of Slump with broken bricks replacement

3.1.5 Compressive Strength

Table 3 shows the compressive strength test results of the replaced broken bricks Concrete

Table 3: Compressive Strength of the replaced Broken Bricks

Replacement (%)	Compressive Strength (N/mm^2) at 7 days	14 days	21 days	28 days
0	15.29	18.46	20.45	23.63
10	14.39	16.12	19.94	21.85
20	14.68	16.12	19.94	20.30
30	14.55	15.23	19.41	19.29
40	14.22	14.87	19.26	18.26
50	13.41	14.82	17.78	18.22
60	10.75	13.67	14.81	16.45

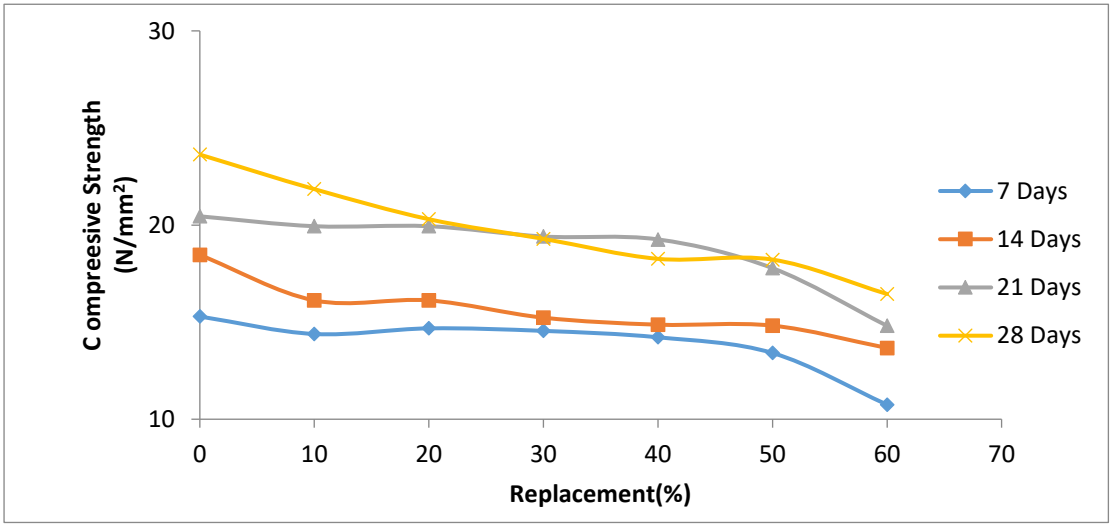

Fig 3: Compressive strength of the replaced broken bricks concrete

3.2 Discussion

The corresponding values from Figure 2 shows that the slump height kept decreasing when more of the broken bricks were added (replaced).The water/cement ratio affected the slump based on the values gotten. The type of slump associated with all the tests performed in the different percentage replacements is the shear slump. The value for slump decreased drastically to 0 at the 60% replacement, which shows that the workability have fading off and means that the concrete is no longer workable beyond the 60% replacement. The result from Table 3 clearly shows that the compressive strength of concrete increased as the number of curing age's increased, the result also shows that decrease in compressive strength of the concrete is as a result of increase in percentage of broken bricks, that is as more and more bricks were been added, the concrete compressive strength kept reducing.

4. CONCLUSION

From this study, it can be concluded that;

1. Workability of concrete varies inconsistently with gradual increase in the quantity of broken bricks replacement.

2. The compressive strength of the concrete decreases on progressive substitution of Bush gravel (Bida natural stones) for broken bricks in the concrete.
3. The compressive strength of the concrete is higher and much enhanced when the cubes are stored for a longer curing ages.

Acknowledgements

We wish to appreciate the School of Environmental Technology International Conference (SETIC) 2020 committee for the privilege to publish this work. We also want to acknowledge the Civil Engineering laboratory, Federal University of Technology Minna for the supports and help received while the research work was on on-going. All staffs of the laboratory are duly acknowledged.

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Influence of Magnesium Sulphate on the Compressive Strength of Internal Cured (IC) Rice Husk Ash based High Performance Concrete

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Abstract
The incorporation of superabsorbent polymers (SAP) and pre-saturated lightweight aggregate (LWA) as internal curing agents (IC) have been proven to be more effective and acceptable in autogenous shrinkage and self-dessication mitigation. However, the incorporation of the internal water reservoirs (SAP & LWA) increases the porosity of the concrete matrix which can injure the strength and durability properties of the HPC. This paper explores the use of the two IC agents as internal curing agents and the comparative study was investigated on their influence on compressive strength of RHA based high performance concrete in aggressive $MgSO_4$ environment. HPC mixtures of designed C55/67 target minimum cube strength at 28-day were studied. Concrete cubes of 100 mm were cast and cured in both water and $MgSO_4$ solution for 28-day hydration period. The result reveals that the mix with LWA ($PHPC_1$) is better with the highest residual compressive strength compared to the SAP mixes in terms of MgSO4 resistance but other way round in terms of the compressive strength of specimens cured in water.

Keywords: *Internal Curing, High-performance Concrete, Superabsorbent Polymers, Rice Husk Ash, Pre-soaked Pumice*

INTRODUCTION

The declination in giving up the trend in the usage of High Performance Concrete in building construction in the recent years is getting wider because of their unique properties of high strength, high durability, high modulus of elasticity and construction of tunnels, bridges, precast pylons, tall buildings and parking garages with the possibility of having relatively thin sections (Aïtcin, 2004 and Orosz, 2017). The HPC production had also known to require the use of other supplementary cementitious materials (SCM) and most especially the silica fume (SF) which is much cost and not available in some Sub-Saharan Africa especially in Nigeria. Therefore, the non-availability and the high cost of the SF geared up the researchers towards the local sourcing of the alternative materials and as a result necessitated the incorporation of the Rice Husk Ash (RHA) which has been reported as a very reactive good pozolanic activity and as a good, effective and efficient substitution to silica fume (SF) (Olawuyi *et al.*, 2020).
The high-performance concrete may not turn out to be durable and maintenance free because these concrete mixtures may generate too much heat and are characterized by high autogenous and drying shrinkage, and therefore is prone to cracking due to restrained shrinkage at early age (Schrofl *et al*., 2012). Autogenous shrinkage could be described according to Jensen and Hansen (2001) reported by Olawuyi (2016) as the measurable change in external volume of a concrete mixture due to chemical shrinkage. High-performance concrete mixtures were developed due to a growing focus on durability and are created by the use of lower water-cementitious materials (w/c) ratios, chemical admixtures and supplementary cementitious materials (SCMs) (Hoff, 2002). However, such performance can only be achieved if the cementitious system is well hydrated, meaning that it has to be well cured and concrete with w/b ratios less than about 0.42 do not have enough water to fully hydrate the cement in the mixture (Schrofl *et al*., 2012).

According to Byard and Schindler (2010), as the cement in a concrete mixture hydrates, water in the capillary pores is consumed. This process decreases relative humidity in the mixture and increases the temperature and internal stresses, resulting in an increased risk of drying shrinkage and cracking (ACI (308-213) R-13 2013). In order to reduce the risk of the autogenous shrinkage, it is necessary to mitigate the decrease in relative humidity in the mixture during hydration and this can be achieved by using internal curing approach as the low porosity characteristic of HPC had hindered the possibility of rapid water percolation into the cement matrix by means of external curing and thereby called for an intensive studies in internal curing (Bentur *et al*., 2001), Internal Curing (IC) according to ACI (213-03R) is defined as the process whereby the hydration of cement continues because of the availability of the internal water that is not part of the mixing water and could be achieved through the incorporation of IC agents that have the ability and capability to absorb and retain water in the system then release when the condition changes (Byard and Schindler, 2010). Hence, reduces the capillary stresses and provide additional water for cement hydration.

Many researchers have incorporated different IC agents in concrete but with pre-saturated lightweight aggregate (LWA) and superabsorbent polymers (SAP) been the most acceptable (ACI (308-213) R13, 2013; RILEM Rep 041 - Jensen and Lura (eds.), 2006). According to the literature (Olawuyi and Boshoff, 2017) that studied the micro-structure and porosity of the concrete matrix using Computer Tomography (CT) Scanning and Scanning electron Microscope (SEM) discovered that the incorporation of these IC agents caused a change in the concrete's micro-structure which resulted in to an increase in the porosity of the concrete. As a result, the incorporation of these IC agents (SAP and LWA) which led to an increase in the porosity of the concrete might allow the penetration of aggressive chemicals in to the concrete matrix which may affect the concrete strength and durability because most of durability problems in cementitious composites involve the ingress of water and aggressive chemicals (Taylor, 2014). As a result, the incorporation of these IC agents (SAP and LWA) which led to an increase in the porosity of the concrete might allow the penetration of aggressive chemicals most especially the sulphate ions in to the concrete matrix which may affect the concrete strength and durability because most of durability problems in cementitious composites involves the ingress of water and aggressive chemicals such as sulphate attack.

The concrete's sulphate attack is one of the problems of durability facing the reinforcing steel and other materials using in the production of concrete. The negative effects of the sulphate attack on concrete as identified by Neville (2012) encompasis cracking, spalling, loss of strength and other effects because most concrete structures are having direct contact with the ground (soil) and the water beneath (i.e. the underground water) which possible that the sulphate ions might be present. The sulphate ions from the seawater, ground water and soil are discovered to be mixed together with some other ions such as magnesium, potassium, calcium and sodium ions. The aggressiveness of sulphate environment was classified in accordance with the Durability Guide Act 201 Committee based on the SO_4^{2--} (g/l) concentrations and was later affirmed that $MgSO_4$ environment is the most aggressive environment. When this $MgSO_4$ reacts with cement compounds most especially the C_3A and the lime $\{Ca(OH)_2\}$ including the CSH, they decomposed and formed gypsum and ettringite in detriment to cement property and produce softening and expansive deterioration types. The mechanical properties of concrete were affected under the attack of sulphate as a result of the delayed ettringite crystal effect enhancement and weakening effect of damage evolution (Syamsul, 2017; Olonade, 2016).

The development and nucleation of delayed ettringite crystal fills the pores of samples and led to a decrease in the porosity of the concrete in the first stage of sulphate attack but resulted in to an increase in the surface hardness of samples. On the other hand, the surface hardness

decreases owing to the damage in surface of the concrete caused by by the expansion force of the delayed ettringite (Syamsul, 2017). The blended cement incorporated RHA as a mineral admixture led to a reduction in the ettringite formation owing to a decrease in the quantity of lime {$Ca(OH)_2$} and C_3A as a result of the additional CSH produced by the RHA reactivity. Thus, enhanced concrete resistance against sulphate attack (Neville, 2014; Ramezanianpour *et al*., 2009). The severe affected structures built in marine environment and concrete sewers hydraulically (Olonade, 2016). Many concrete structures affected by sulphate often prone to maintenance or complete rehabilitation that attract substantial expenditure that could have been directed for new structures production. Furthermore, man-hour is lost while operation would be grossly affected during repair and thus, the cost incurred as a result of maintaining the sulphate attack on concrete is substantial to bear.

Internal curing (IC) agents of different types have been incorporated in different studies as said earlier by many researchers but with SAP and pre-soaked saturated LWA being the most acceptable (ACI (308-213) R13, 2013; RILEM Rep 041 - Jensen and Lura (eds.), 2006). The SAP is somehow expensive due to its availability in just some limited places and as a result geared the researchers towards the local sourcing of the alternative materials that led to the development and incorporation of the pre-soaked saturated LWA that is locally available (Schrofl *et al*., 2012). It is now of particular importance to check the influence of these IC agents as a result of a change in environment on the strength and durability performance of RHA based HPC since the first yardstick in measuring the performance of the concrete is by checking its strength and extremely, high durability properties are the main benefits of HPC. The study will therefore be filling the gap by examining the comparative study of the effectiveness of these two IC agents on strength and durability performance of RHA based HPC as the study incorporated these two IC agents as a comparative study are scarce in literature.

EXPERIMENTAL INVESTIGATION

Materials

The constituent ingredients utilized in this research work are namely: IC agents (SAP & LWA), Natural Sand, Crushed Stone, Binder (PC & RHA), Water and Superplasticizer (SP). Superabsorbent polymers (labelled FLOSET 27CS) of ≤ 600 μm grain size produced in France by SNF Floerger was added at 0.2% by weight of binder (b_{wob}) as detailed in Olawuyi and Boshoff (2018) considering 12 g/g as the SAP absorption capacity conforming to the requirement of SAP specification for the production of HPC determined by tea-bag test (Olawuyi *et al*., 2021). The SAP type used is a thermoset polymer specifically the covalently cross-linked polymers of acrylamide and acrylic acid obtained from bulk solution polymerization and neutralized by alkali hydroxide. The pre-soaked LWA incorporated was a porous igneous rock formed as a result of explosives volcanic eruptions which was later crushed and 13 mm maximum size was incorporated (Olawuyi *et al*., 2020).

The river sand (natural) conforming to medium sand classification was used according to Shetty (2004) as the fine aggregate (i.e. the requirement specifications for the production of HPC) with a minimum particle size of 300 μm (Nduka *et al*., 2020; Olawuyi *et al*., 2020; Aitcin, 1998; Beushausen and Dehn, 2009; Neville, 2012). A greywacke crushed stone of 13 mm maximum aggregate size was used as the coarse aggregate in accordance with typical HPC mixtures reported in the literature (Beushausen and Dehn, 2009; Neville, 2012; Olawuyi *et al*., 2021). In order to achieve a reduction in the dust content of the aggregate for less water demand by the mixtures, the crushed stone was washed and surface dried before the usage.

Also, in accordance with BS EN 197-1 (2011) and NIS 444-1 (2003), CEM II/A-LL, 42.5N was used as the main binder in compliance with requirement for PC specification for the

production of HPC. The supplementary cementitious material (SCMs) used was the RHA obtained from rice husk acquired from a rice mill at Minna, Niger State, Nigeria and incorporated at 10% by weight of the PC. The RHA was calcined using a locally fabricated incinerator in a controlled environment at a temperature below or equal to 700^{o}c. A sky 504 masterglenium polymer-based polycarboxylic ether (PCE) superplasticizer supplied by Armorsil Manufacturing Incorporation was used as the chemical admixture (superplasticizer) and constantly administered at 1.5% concentration by weight of binder (b_{wob}) as used in the typical HPC mixtures (Olawuyi, *et al.,* 2020; Nduka *et al.,* 2020). As recommended in the work of Aitcin (1998) reported in Olawuyi *et al.* (2021), the water content of the superplasticizer was removed from the volume of water used in mixing in order to maintain the original W/B designed for (i.e. not to cause an increase in the designed W/B) and a portable cleaned water in accordance with the specification of BS EN 1008 (2002) was used for the mixing at 0.3 W/B reported by Ogunbayo *et al*. (2018).

The production of the specimens was achieved through the use of a concrete mixer in Building Laboratory Department, Federal University of Technology, Minna. The fine aggregate was first poured in to the mixer followed by the binders (PC & RHA) after which both (PC & RHA) have been thoroughly mixed manually with each other and a homogeneous mixture had been achieved. The granite was added after mixing for about 30 seconds and the mixing continues for another 1 minute before adding about 75% of the mixing water. A masterglenium (sky 504) superplasticizer was pre-mixed with the remaining 25% of the mixing water, this is added to the mixture and mixed further for 3 minutes. The other mixes also followed the above steps just that the saturated lightweight aggregate (LWA) was added together with the granite before the addition of water for the mixes incorporated LWA. Furthermore, for mix incorporated SAP, the dry SAP particles was added immediately after the 30 seconds addition of binders and sand. Hence, all the fine contents (sand, binders & SAP) were allowed to be mixed together for about 30 seconds as well for even dispersion of the SAP particles before the addition of granite and water respectively as discussed before and recommended in the literature (Aitcin, 1998; Mehta & Monteiro, 2014; Neville, 2012).

Methods

Properties of Constituents Materials

The particle size distribution of the aggregate's samples (sand, granite and LWA) was determined by wet sieving while the specific gravity of the aggregates and binders were also determined in the Building Concrete Laboratory of Federal University of Technology, Minna. Section 3.3 further present and discuss the result of the physical properties of the constituent materials.

HPC Specimens Production

A target strength of 60 MPa at 28-day characteristic strength was adopted as the reference mixture (CHPC) which was designed in accordance with the work of Aitcin (1998) reference method of HPC mixtures as reported in the literature (Nduka *et al.,* 2020, Olawuyi *et al*., 2021) showing in table 3.1 below. Furthermore, other HPC mixtures incorporating SAP at 0.2% ($S^{0.2}$) by weight of binder (b_{wob}) and 5% (P^{5}) and 7.5% ($P^{7.5}$) of pre-saturated lightweight aggregate by weight of coarse aggregate (b_{woca}) at constant W/B of 0.3 were also produced. The binder comprises of 90% Portland cement and SCM of 10% (PC+RHA).

Fresh Property

The flow table test was used in carrying out the slump flow measurement as described in BS EN (12350 - 5 - part 1) as a measure of workability of the HPC mixtures. When the required

workability and cohesion (400-600 mm slump flow spread) for the specified design mix had been met, the specimens for both the curing regimes (i.e. curing in water and $MgSO_4$ solution) were cast as explained in section 2.2.1 and 2.2.2 and de-moulded after 24h of casting.

Table 8: Materials mix proportioning

Materials	Mixture types (kg/m^3)			
	Reference	HPC with SAP	HPC with pre-soaked pumice	
	CHPC*	SHPC*	$PHPC_1$*	$PHPC_2$*
CEM II 42.5 N	485	485	485	485
Rice Husk Ash (10%)	55	55	55	55
Superplasticizer (1.5% b_{wob})	8.1	8.1	8.1	8.1
Fine sand	700	700	700	700
Coarse aggregate	1050	1050	997.5	971.25
Pre-soaked pumice			52.5	78.75
SAP (0.2%)		1.08		
Water	156	156	156	156
Additional water for SAP		12.5g/g of SAP		
W/B	0.3	0.3	0.3	0.3

*CHPC is Control HPC, SHPC is SAP HPC (containing 0.2% SAP b_{wob}); $PHPC_1$ is Pumice HPC (containing 5% pumice b_{woca}) and $PHPC_2$ is Pumice HPC (with 7.5% pumice b_{woca})

Specimen Production and Testing

A total of 72 (100 mm) specimens were tested in which 36 were cured in ordinary water and the other 36 were cured in 5% $MgSO_4$ solution to determine the resistance in an aggressive sulphate environment. The specimens were tested for compressive strength in accordance with BS EN 12390-3 (2019) at 28-day and the strength was determined by dividing the crushing load with the area of the cube specimen. Three concrete specimens were tested for each mix and average reported.

RESULTS AND DISCUSSION

Physical properties of Constituents Materials

Table 2 reveals the fine aggregate to have a coefficient of uniformity (C_u) of 2.39, coefficient of curvature (C_c) of 0.94 and fineness modulus (FM) of 2.87 conforming to standard specification stated by Shetty (2004) to be a medium sand classification while the coarse aggregate used for the study is a uniformly graded stone. The outcome of the results of the physical properties shown in Table 2 makes it crystal clear that both the fine and coarse aggregates are suitable for HPC production.

Table 9: Physical Properties of Materials

Item	Sand	Granite	Pumice	RHA	PC
D_{10}	360	10000	10000		
D_{30}	540	11000	11000		
D_{60}	860	13000	13000		
C_u	2.39	1.30	1.3		
C_c	0.94	0.93	0.93		
FM	2.87				
SG	2.80	2.8	1.80	2.10	3.14

Fresh Properties of HPC

The results of the flow table test conducted on the mixes before casting revealed that the mixes comply with the target limits of 400-600 mm slump flow for all. This implies that irrespective of the IC-agents incorporated, the consistency and the workability were similar.

Compressive Strength of HPCS

The compressive strength test was carried out at 28th day with water and $MgSO_4$ solution as the curing media. Table 3 and Figure 1 presents the various HPCs compressive strength with the same binder proportions. The result shows that the compressive strength of the HPCs having IC-agents incorporated are slightly higher than the control in the two-curing media. The loss in compressive strength as influenced by $MgSO_4$ was observed as 3.84%, 1.26%, 0.36% and 1.62% for CHPC, SHPC, $PHPC_1$ and $PHPC_2$ of HPCs respectively as compare to the specimen cured in water. Furthermore, the result also revealed that the HPC incorporated SAP (SHPC) has the highest compressive strength of 59.14 MPa in water and 58.40 MPa in MgSO4 while the HPCs incorporated LWA with compressive strength of 58.02 MPa ($PHPC_1$) and 57.89 MPa ($PHPC_2$) in water but 57.81 MPa ($PHPC_1$) and 56.95 MPa ($PHPC_2$) in MgSO4.

Table 10: Influence of Curing Media on Compressive Strength

Specimen Number	Curing Media		CS28w	CS28c	Loss%	Residual CS
	Water	MgSO4				
CHPC	54.96	52.85	100	96	3.84	96.16
SHPC	59.14	58.40	108	106	1.26	98.74
PHPC1	58.02	57.81	106	105	0.36	99.64
PHPC2	57.89	56.95	105	104	1.62	98.38

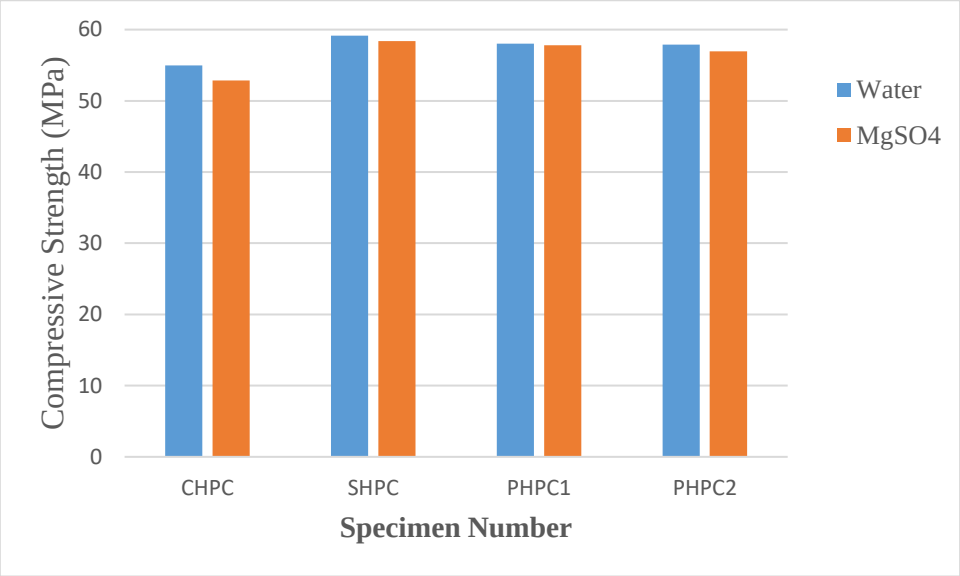

Figure 3: Influence of Curing Media on Compressive Strength

SUMMARY OF FINDINGS

The following are the inferences deduced from the study

i. The RHA used as the SCM is a good alternative to silica fume
ii. Use of SAP and saturated Pumice (i.e. LWA) as IC-agents improved the 28-day compressive strength of the HPCs.
iii. MgSO4 as a curing media resulted in slight loss in compressive strength values for all HPCs studied.

iv. The HPC incorporated SAP shows higher compressive strength in both curing media in relation to other HPCs mixtures (i.e. $PHPC_1$ &$PHPC_2$).

v. HPCs containing SAP as IC-agent had better performance than those containing presoaked Pumice in compressive strength values but were noted to exhibit lower residual strength values.

CONCLUSIONS AND RECOMMENDATION

The present research work explored the effectiveness of the SAP and presoaked Pumice as IC-agents in C55/65 RHA based HPC made from binary binder consisting of cement and 10% RHA with administration of Masterglenium sky 504 superplasticizer. The study revealed that the two IC-agents have effect on the strength and durability properties of the HPC but more pronounced in SHPC. The SHPC has a residual strength of 98.74 %; $PHPC_2$ has 98.38 % while $PHPC_1$ revealed the highest residual strength of 99.64 %.

The study thereby recommends the use of presoaked Pumice of Nigeria origin at 5% b_{woca} for the Class of RHA based HPC studied.

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Influence of Material Waste Management on Construction Project Delivery in Abuja, Nigeria

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Abstract:
Construction Waste Management is an aspect of Sustainable Development, which is fueled by the growing need of man for infrastructural amenities. Improper control of materials during different stages of construction has some influence on construction project delivery. The aim of this study was to assess the influence of materials waste management on construction project delivery in Abuja by identifying the sources of construction material waste, evaluating the influence of materials waste management on construction project delivery and the performance techniques and strategies of reducing construction materials waste in a construction project. Quantitative methodology was used, involving the use of questionnaires to obtain data which was analysed to obtain the RII. The result revealed that the most influence of materials management on construction project delivery are; time overrun/delay, productivity, cost overrun/increase project cost, environmental impacts, brings contractors to disrepute among others. the results also reveal that the performance of some of the strategies of reducing the effects of materials waste management which are; materials planning method, materials handling, proper planning, monitory, and control of materials, and materials waste control. The researcher recommends the use of these strategies and measures to minimize the influence of materials waste management on construction project delivery

Keywords*: Waste Management, Project Delivery, Material Waste, Sustainable Development, Infrasturutures*

1.0 INTRODUCTION

Constructions projects are sophisticated and complex processes that needs to be carried out by individuals with special set of skills and knowledge that is channeled toward achieving sustainable project deliver (Ocheoha & Moselhi 2013). According to Umar (2021) proper material waste management on construction sites leads to project that are delivered within acceptable cost and required standards thus providing facilities that are useful and functional to occupy. Waste management in construction site is very essential because improper management of materials during site activities has the potential to severely affect project performance and delivery (Mohammed, 2019). According to Takim & Akintoye (2012) the major issues that affect materials management activities include constraints on storage areas, site logistics concerning materials handling and distribution, ordering and delivery of materials to the construction site, improper storage, transportation difficulties and inappropriate materials delivery and non-compliance with specification according.

Construction activities generate wastes at various stages of the construction process from inception, right through the design, construction and operation stages of the built structure (Wahab & Lawal, 2011). According to Gulghane & Khandve (2015) construction waste is a complex waste stream made up of a wide variety of materials which are in the form of building debris, rubble, earth, concrete, Steel, timber, and mixed site clearance materials, arising from various construction activities including land excavation or formation, civil and building construction site, clearance, demolition activities, roadwork, and building renovation.

Wastage of materials will lead to increase in total cost of building project; this assertion is supported by (Mohammed, 2019). who opined that building material wastage on construction sites contributes to cost overruns, time overrun, productivity, litigation and environmental pollution. This implies that in-depth review, identification of causative factors of waste, assessment of these factors and any improvement in materials wastage management on construction sites will enhance the cost performance of projects delivered in Nigeria. This study therefore, intends to provide answers to the following research questions which include:

What are the causes of construction material waste?
What is the influence of materials waste management on construction project delivery?

2.0 LITERATURE APPRAISAL

2.1 Material Management

Materials management practice involves planning, coordinating and assessing the requirement for sourcing, purchasing, transporting, storing of materials to minimize wastage and optimize profitability (Umar 2021). According to Phu & Cho, (2014).Materials Management involves management system for planning and controlling all necessary efforts to make certain that the right quality and quantity of materials and equipment are specified in a timely manner, are obtained at a reasonable cost and are available when needed.

2.2 Construction Waste

Waste in construction occurs in various construction stages ranging from design to finishing and they emanate from wooden materials, concrete, gravels, aggregate, masonry, metals, plastic, plumbing and electrical fixtures, glass and material handling (Napier, 2012). According to Mohammed (2019), construction waste are materials transported off the construction sites or used within the construction sites for land filling, incineration, recycling, reusing or composting other than the intended specific purpose of the project as a result of material damage, excess, non-use, or non-compliance with the specifications or being a byproduct of the construction process. Construction waste are unwanted materials generated during construction, they include rejected structures and materials, materials which have been over-ordered or are surplus to requirements, and materials which have been used and discarded (Ahmed 2019)

2.2.1 Construction Material Waste

According to Gulghane & Khandve, (2015) construction waste can be divided into three namely: material, time and machinery. However, this research focuses on materials waste which according Kevin (2012) refer to materials on construction sites that are unusable for the purpose of construction. Similarly, according to Ameh & Itodo (2013) material waste include materials that are not needed on the site and needs to be transported away from the construction site, these materials are not used for their intended purpose of the project due to damage, excess or non-use or which cannot be used due to non-compliance with the specifications, or which is a by-product of the construction process.

2.3 Causes of Construction Materials Waste

According to Mohammed (2019) the main causes of construction waste are: Poor coordination of all parties during the design stage, Design changes, Lack of attention to the standard size of specific products, Error in contract documentation, Material delivery procedures, Material storage and internal transport. Similarly Shant, & Daphene, (2014) identifies Inappropriate storage, Errors by tradesman, Inclement weather, Equipment problems, Use of incorrect material, Accidents, Poor site management and supervision, Lack of coordination of responsibilities between contractor and subcontractors as some of the causes of construction material waste.

Ekanayake *et al.* (2009), found the causes of construction waste in Singapore construction industry sites are Lack of attention paid to dimensional coordination of products, Changes made to the design while construction is in progress, Lack of attention paid to standard sizes available in the market, Designer's unfamiliarity with alternative products, Complexity of detailing in the drawings, Lack of information in the drawings, Errors in contract documents,

Incomplete contract documents at commencement of project, Selection of low quality products, Errors by tradespersons or laborers, Accidents due to negligence and Damage to work done caused by subsequent trades. Similarly Adewumi & Otali (2013) identify the use of incorrect material, Delays in passing of information to the contractor on types and sizes of products to be used, Equipment malfunctioning, Damages during transportation, Inappropriate storage, Materials supplied in loose form, Unfriendly attitudes of project team and laborers, Theft, Ordering errors (e.g. ordering significantly more or less), Lack of possibilities to order small quantities, Purchased products that do not comply with specification as causes of construction material waste.

2.4 Influence of Materials Waste Management on Construction Project Delivery

Management of construction material is a new practice in the construction industry Ocheoha & Moselhi (2013). Therefore, reviews of literature summarize the influences material waste management will have on project delivery in Table 2.0. The influence of materials waste management on project delivery can be identified both from a positive and negative perspective effects. From positive effects, effective material management has a positive impact on time optimization, cost saving, quality maximization, productivity improvement and waste minimization. On the other hand, this research work will focus on the negative effects on project delivery such as time delay, cost overrun, poor quality, loss of productivity and excessive waste generation. However, in the table below more influence of materials waste management are listed.

Table 2.0 Influence of Materials Waste Management on Construction Project Delivery

S/N	Influence of Materials Waste Management on Construction Project Delivery
1.	Time overrun/delay
2.	Cost overrun/increase project cost
3.	Dispute
4.	Arbitration
5.	Litigation
6.	Quality
7.	Productivity
8.	Total abandonment
9.	Insolvency as a result of loss
10.	Decrease in turnover
11.	Brings contractors to disrepute
12.	Environmental impact

Source: literature survey 2021

3.0 RESEARCH METHODOLOGY

Quantitative methodology was used which involves the use of questionnaire to obtain data. Questionnaire was used to collect data on the influence of materials waste management on construction project delivery in Abuja. The target population of the research was total 245 officially enlisted construction firms in Abuja obtained from the headquarters of the Federal Capital Territory Administration (FCTA), Abuja. Since not all the firms could be included in the study a purposive sampling technique was adopted. This involves the deliberate selection of 43 construction firms in Abuja to constitute the sample size for this research work.

4.0 DATA PRESENTATION ANALYSIS AND DISCUSSION OF RESULTS

4.1 Demography of Respondents

It can be seen from the table 4.1 that builders are the majority of the respondents with BSC/BTECH holders having the highest numbers while 5-10 years' experience being the majority of the respondents. Table 4.1 summary the respondents profile

Table 4.1: Summary of Respondents Profile

Variable	Characteristics	Number of Respondents	Percentage (%)
Profession	Builders	15	34.9
	Architects	5	11.6
	Civic engineers	15	34.9
	Surveyors	8	18.6
	Total	43	100
Academic Qualification	HND	9	20.9
	BSC/BTECH	24	55.8
	PGD	7	16.3
	MSC/MTECH	3	7.0
	Total	**43**	**100**
Years of experience	Below 5	11	25.6
	5-10	21	48.8
	10-15	6	14
	15-20	3	7
	Above 20	2	4.6
	Total	**43**	**100**

Source: Field Work (2021)

4.2 Influences of Materials Waste Management on Construction Project Delivery

Table 4 presents the result of the study. There are various Influences of materials waste management causes posited in various literatures. Respondents were requested to choose in terms of relevance among the Influences of Materials Waste Management as seen in the Table.

Table 4.3: Influence of Materials Waste Management on Construction Project Delivery.

Influence of Waste Management	RII	Ranking
Time overrun/Delay	0.842	1
Cost Overrun/Increase project cost	0.833	2
Dispute	0.753	6
Arbitration	0.712	9
Litigation	0.740	7
Quality	0.735	8
Productivity	0.842	1
Total abandonment	0.791	4
Insolvency as a result of loss	0.702	10
Decrease in turnover and Profit	0.777	5
Brings contractor to disrepute	0.814	3
Environmental Impact	0.814	3

Source: Field Work (2021)

4.3 Discussion of Results

From the survey carried out, it is impressive to know that all the influences of materials waste management on construction project delivery have high RII rating as it is above 0.60. The respondents ranked "Time overrun/Delay" with a very high RII rating of 0.842 as the most important influences of materials waste management on construction project delivery, While "Insolvency as a result of loss" was the least with rating of 0.704.

5.0 CONCLUSION AND RECOMMENDATION

Influences of materials waste management on construction project delivery were identified from literature survey and were used to obtain data. RII was used for data analysis with "Time

overrun/Delay" identified as the most important Influence of materials waste management on construction project delivery, while "Insolvency as a result of loss" was the least relevant Influence of materials waste management on construction project delivery. Construction firms should be encouraged to integrate materials waste management in all aspect of project implementation so as to achieve sustainable project delivery.

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Effective Implementation of Health and Safety Practices on Construction Site: Barriers and Movers

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Abstract
Full implementation of health and safety (H&S) practices in construction has been a tough battle over the years. The literature indicates that enforcement by statutory authority is one of the key factors for effective implementation. However, the level of enforcement by the statutory authority in Nigeria is very low. Hence, the need for active means of implementation of H&S practices in Nigerian construction. Therefore, this paper investigated the barriers and movers of effective implementation of H&S management practices in construction site in Abuja the Federal Capital City of Nigeria where there were several ongoing projects during the study. Structured questionnaire and review of relevant literatures were used to obtain data for the study. Importance index was the major statistical tools used in analysis of the data obtained. The study identified absence of provision for cost of H&S practices in the bill of quantities, lack of record of performance as perquisite for tender selection, inadequate training of staff and clients influence as the most important factors inhibiting effective implementation of H&S practices in Nigerian construction site.

Keywords: Construction, Health, Safety, Implementation, Practice.

INTRODUCTION:

The construction industry provides the necessary infrastructures that stimulate National development and it provides about 25% of the total work force in Nigeria (Cheah *et al.*, 2007; Rao *et al.*, 2015). The industry is labour intensive and incorporated floods of human resources and machines, therefore health and safety management practice on the constitution site is paramount (Enhassi *et al.*, 2008: Alhageri, 2011).

It has been reported worldwide that the construction industry is one of the must risky and hazardous industry, and that in every six fatal accidents; one must be on a construction site. (Spillane and Oyedele, 2013; Umeokafor *et al.*, 2014). This was further eluded that about 60,000 and above fatal accidents occurred on construction sites around the world every year (Health and Safety Executive, 2004). This risky and hazardous nature of the construction job is still controllable, depending on the work conditions which is humanity controllable, (Olutuase, 2014). The worries and questions being raised by many researchers and some constructions professionals is that why should worst safety and health conditions persist on construction site in Nigeria and other developing nations of the world, seeing that there are windows through which health and safety conditions of the construction workers can be improved.

The answers of these questions raised are not farfetched from the assertion of Makinde (2014) that there is a need for special attention to health and safety management practice on construction firms in Nigeria. The target of this paper is to investigate the various factors that negatively and positively influence effective implementation of H&S practices on construction site in Abuja with a view to effectively implement H&S practices in Nigerian construction.

LITERATURE REVIEW

Factors hindering health and safety practices implementation on construction sites

The factors hindering the effective implementation of H&S practice on construction sites are not limited to weak statutory occupational Health and safety regulations/provisions; lack of management and stake holder's commitment to occupational H&S; lack of enforcement of H&S regulations by the enforcement authority; bribery and corruption; absence of H&S officers on site (inspectors) to monitor implementation; in adequate training of construction workers; lack of awareness and improper medium for communicating information; activities of the informal sector; leaving the implementation of H&S practice at the discretion of the construction firms or employer; inadequate/untimely provision of personal protective equipment (PPES); lack of H&S signs and notice on site, and lack of regular safety audit (Oyedele, 2013; Enhassi *et al.*, 2008; Alhageri, 2011).

Strategies for effective implementation of Health and safety practices on construction sites

Othman (2012), Nzuve and Lawrance (2012) outline some of the measures that can be used to overcome the factors that hinder the effective implementation of H&S practice in construction projects. These measures are to: identify hazard from the beginning or from the earliest design stage and through all other steps in the engineering process; isolate workers from harmful substances; potential dangerous substances should be replaced with the one that secure a healthy and safety working environment; train workers and medically examine them before employment, and make available all medical programmes that could lead to standard or effective H&S of employees on construction site.

METHODOLOGY

This study aims to investigate the barriers and movers for effective implementation of H&S practices on construction site with a view to effectively implement H&S practices in Nigerian construction. To achieve this aim, survey research design was adopted. To be precise, the survey research design adopted in this study involved collection of quantitative data through structured questionnaire. The study population included all the firms that were registered with Federal Capital Development Authority (FCDA) Abuja. The preliminary investigations on the registered firms with FCDA during the study indicated that the firms of all categories (Small, medium and large firms) that have fully registered with FCDA were 188 in number. This 188 served as the targeted population of the study. In order to obtain the true representation or sample size of the population, purposive technique was adopted (Bernold and lee, 2010). Therefore, emphasis was placed on the firms that have ongoing project (s) on site, and their employees were willing to participate in the study. These conditions were serious elimination weapons that was used to reduce the total number of firms from 188 to only 34. The 34 are from both medium and large construction firms in the study context.

After extensive literature review on the barriers and movers of H&S practices on site, a structured questionnaire was designed to seek information on the opinions of construction stakeholders on the factors that hinder the effective implementation of H&S practice on construction sites. The designed questionnaire was also used to obtain data on probable movers for effective implementation of H&S regulation on construction sites. The questionnaire was

administered directly to the managers of each studied site and collected after filling by the respondents. This implies that a total of 34 questionnaires were distributed to the selected 34 sampled construction sites in Abuja. All the 34 questionnaires were duly completed and returned indicating 100% response rates for the study. The participants of the questionnaire study were asked to rank the barriers/movers of H&S practices implementation on site on a Likert of 1 to 5 which was used to establish the mean item score (MIS) of each discovered variables. The academic qualifications of the respondents ranges from first degree to PhD holders. All the respondents were well experienced as they have been involved in different projects over the years. The data obtained was analysed through descriptive and non-descriptive statistical methods of data analysis.

RESULS AND DISCUSSION

The result of the analysis of data collected for this study is presented in tabular form and discussion follows.

Table 1: Bearers to effective implementation of Health and Safety Practice on Nigeria Construction site.

Factors		SI	Ranking
v.	Absence of provision for the cost of health and safety measures from BOQ	0.913	1
v.	Lack of commitment to health and safety at work place by stakeholders of construction project	0.862	2
vi.	Designer not taken into consideration health and safety problem associated with subsequent maintenance and up keep of building at designer stage.	0.821	3
ii.	Absence of government safety inspectors to monitor implementation of HSP on construction sites	0.781	6
ii.	Lack of management's commitment on health & safety practice at work place	0.790	5
x.	Refusal of the employees to use personal preventive equipment (PPE) provided	0.690	9
x.	Non-availability and inadequacy of clinical services for employees	0.770	7
xi.	Refusal of employees to adheld to HS laws and instruction	0.811	4
ii.	Lack of orientation for new workers	0.670	11
ii.	Inadequate and total absence of first aid and medical arrangements	0.683	10
v.	Absence of induction training	0.700	8
v.	Lack of safety plans	0.632	14
vi.	Lack of clarity or total absence of emergency exit	0.641	13
ii.	Lack of regular safety audit	0.656	12
ii.	Inability of the management to identify hazards	0.541	15
x.	Lack of health and safety signs and notices	0.512	16
x.	Unfriendly site conditions and security	0.490	18
xi.	Willful interference with anything provided in the interest of health and safety	0.500	17

Table 1 present barriers to effective implementation of health and safety practices on Nigeria construction sites. The respondents indicated eighteen (18) factors that militate against successful implementation of H&S practices in Nigeria construction sites. Based on the MIS of the variables, it can be emphasized that absence of the provision for the cost of H&S measure in tender document (BOQ), lack of stakeholder's commitment to H&S at work place, and designers not taken in consideration H&S problem associated with subsequent maintenance/up keep of building at design stage are the significant factor that inhibit effective implementation of H&S practices in

Nigerian construction site. Hence, for effective H&S practices implementation in Nigerian construction, there is need to bring up strategies that can be adopted to overcome the aforementioned barriers for effective H&S implementation in the study context.

Table 2: Movers of Effective Implementation of Health and Safety Practice on Construction Site

Factors	RII	Ranking
• Adequate provision for cost of health and safety measures in tender documents	0.884	1
• Management commitment to health and safety measures (HSM) at work place being noticed and physically seen	0.867	2
• Adequate safety training	0.830	3
• Integrating health and safety of construction workers into design and planning process	0.794	4
• Availability of clinical services for employees	0.776	5
• Adequate and timely supply of PPE	0.743	6
• Safe system of work plans to mitigate personal health and safety issues	0.725	7
• Provision of adequate information of hazard	0.678	8
• Regular health and safety audit	0.614	9
• Presence of government safety inspectors to monitor the implementation of HSP on site	0.587	10
• Taking into account safety problems associated with maintenance and up keep of building	0.546	11
• Must not place at risk the health or safety of any person at the workplace	0.531	12
• Create a sense of security in doing work	0.512	13

Table 2 present factors that enhance effective implementation of H&S practices on Nigeria construction sites. The respondents identified thirteen (13) factors as movers of effective implementation of health and safety practices on construction sites in Abuja Nigeria. The factors were equally ranked based on their importance as movers of effective implementation of H&S practices on construction sites. Based on the outcomes of the study, adequate provision for cost of health and safety measures in tender documents, management commitment to H&S measures at work place and adequate safety training are the significant factors that can be adopted for effective implementation of H&S practices in Nigerian construction site. It is important to also note that all the important index values were more than fifty percent (50%). This implies that all the factors indicated by the respondents in this study play significance role(s) in enhancing effective implementation of H&S practices on construction site in Abuja. This result shows that even though construction job is highly risky and hazardous, it could still be controlled to reduce the risk and the hazard level to the nearest minimum. This will improve the H&S of the workers, which will consequently improve the performance of individuals and the firms at large.

SUMMARY OF FINDINGS

Based on the study conducted, it can be observed that absence of provision for the cost of H&S measures from the BOQ; lack of commitment to H&S measures at work place

by construction actors, and designers not taken into consideration H&S problem associated with subsequent maintenance and up keep of building at the designer stage are the significant factors that have been hindering the effective implementation of H&S practices in Nigerian construction site. It was also noticed that adequate provision for cost of H&S measures in tender documents, management commitment to health and safety measures at work place, and adequate staff safety training are the noteworthy strategies that can be used to reduce some of the factors that hinder the effective implementation of H&S practices in Nigerian construction.

CONCLUSION

This study revealed that the state of implementation of H&S practices in Nigerian construction site is very poor due to certain factors such as absence of provision for the cost of H&S measures from the BOQ and lack of commitment to H&S measures at work place by construction actors. Therefore, for effective implementation of H&S practices in the study context, the aforementioned barriers need to be overcome through certain strategies such as adequate provision for cost of H&S measures in tender documents, management commitment to health and safety measures at work place, and adequate staff safety training by firm management.

Based on the findings and conclusion of this study, it is recommended that a framework for effective implementation of H&S practices in Nigerian construction site should be developed. Such framework should be developed through the significant mover of H&S practices identified in this study. Hence, such framework will enable minimum standard of H&S practices on construction sites to be strictly enforced at every phase of a project.

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Utilization of Quarry Dust as Partial Replacement of Sand in Sandcrete Blocks

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Abstract
The research was based on an investigation of the optimum quantity of quarry dust required to replace sand content in sandcrete blocks, which would yield best quality products. The cement was combined with fine aggregates in ratio of 1:8. The percentage replacements of sand by quarry dust were: 0%, 5%, 15%, 25%, 35% and 45% by volume of fine aggregate. Sieve analysis was carried out to classify the sand and quarry dust. Forty-five sandcrete blocks of 150mm × 225mm × 450mm were produced and tested. Compressive strength test and hygric property (porosity and sorptibity) analysis were conducted. From the results, an increase in compressive strength with the increase in quarry dust was observed. The compressive strength reached its optimum values at 15% replacement, and the values are: 2.18, 2.28, and 2.55N/mm^2 at the age of 7, 14, and 28 respectively. Beyond 15% replacement, increase in quarry dust decreases the compressive strength of the sandcrete blocks. Also, it was observed that, increase in quarry dust decreases porosity and sorptivity.
Keywords: Quarry Dust, Partial Replacement, Sandcrete Blocks, Strength Properties, Aggregates

1.0 INTRODUCTION

Sandcrete blocks are masonry units manufactured from a mixture of cement sand and water. They are largely used as walling materials in construction of buildings and other infrastructures. Sandcrete blocks have been in use throughout West Africa for over five decades as a popular building material for load and non-load bearing walls and foundations (Abdullahi, 2006). Anthony et al. (2015) asserted that, blocks are moulded into various sizes and forms in Nigeria. The sizes are: 225mm × 225mm × 450mm, 150mm × 225mm × 450mm and 100mm × 225mm × 450mm; which may be either solid or hollow. Anosike and Oyebade (2012) opine that Block construction industry is a very important sector of the Nigerian economy. It plays critical role in a nation's economy such as Nigeria because of the transient trend in the national growth. Over 90% of physical infrastructures in Nigeria are being constructed using sandcrete blocks (Baiden and Tuuli, 2004). Oyekan and Kamiyo (2008) opine that sandcrete blocks are manufactured in many parts of Nigeria for a long time without any reference to suit local building requirements or good quality work. They further reported that, Standard Organization of Nigeria (SON) developed a reference document in the year 2000, in an attempt to enhance the best materials and manufacturing practice, which prescribed the minimum requirements and uses of different kinds of sandcrete blocks (NIS, 2000). Among the objectives of this NIS document are to ensure that all block manufacturers meets a minimum specified standard, as well as to control the quality of blocks produced by these manufacturers. Compressive strength of blocks is a measure of the blocks resistance to axial load application (Osuji and Egbon, 2015). The recommended strength by BS 2028 is: Mean strength, 3.45N/mm^2; Lowest individual strength, 2.59N/mm^2. From specification, it implies that the least compressive strength of individual block must be at least 75% of the mean value. The Federal Ministry of Works and Housing (1979), in Nigeria, recommends a compressive mean strength of 2.1N/mm^2 and lowest individual strength of 1.7N/mm^2. The range of minimum strength of sandcrete specified in the Nigeria Industrial Standard is between 2.5N/mm^2 to 3.45N/mm^2 (NIS, 2000). However, the strength of sandcrete blocks is inconsistent due to the different production methods employed, duration of curing, sizes of blocks and the properties of constituent materials (Abdullahi, 2005). Ettu et al. (2013) argue that increasing number of Nigerians in urban and sub-urban districts of the country cannot afford to pay for good accommodation. Academic research in recent years focuses on partial replacement of Portland cement or fine aggregate content by some suitable agricultural waste products, such as rice husk ash (RHA)

and other materials like quarry dust, in the production of sandcrete blocks. These materials are cheaper to obtain, and could generally reduce the production cost of sandcrete blocks. This research therefore is aimed at investigating the strength and hygric properties of sandcrete block produced by partially replacing sand with quarry dust.

2.0 REVIEW LITERATURE

Osuji and Egbon (2015) evaluated the compressive strength of sandcrete hollow building blocks, with the sand fraction partially replaced with quarry dust. They used a range of 0%, 10%, 15%, 20% and 25% sand replacement with quarry dust in the cement: sand mix ratios of 1:6 and 1:8 for moulding blocks of size 225mm x 225mm x 450mm. These blocks were produced by machine compaction under a pressure of $3N/mm^2$. Results indicated that for mix ratio of 1:6 at 28 days when 10% quarry dust partial replacement was applied, the compressive strength of the blocks was about 7% greater than that of blocks without partial replacement. Also, for the mix ratio of 1:8 at 28 days and 10% partial replacement with quarry dust, the compressive strength of the blocks was about 46% higher than that without partial replacement of the sand fraction. They also observed that strength of the blocks increases with increase in quarry dust partial replacement of sand. However, for the mix ratios employed, they noted that 15% partial replacement of sand with quarry dust gave an optimum compressive strength of $3.8N/mm^2$ and $4N/mm^2$ for the two mix ratios respectively. Therefore they suggested that, the optimum replacement of sand with granite quarry dust as fine aggregates should be 15% of the sand fraction in hollow building blocks of the size and mix ratio adopted herein.

Olaniyan et al.(2012**)** assessed the suitability of granite fines as partial replacement for sand in sandcrete block production. They used mix proportion (1:6) for batching in volume and cured by wetting the blocks daily. They carried out compressive strength test on the sandcrete block for each percentage of replacement on 7, 14, 21 and 28 days. The percentage of granite fines replacement used in the research were 0%, 5%, 10%, 15%, 20%, 25% and 100%. Result of their experiment showed that the inclusion of granite fines in the sand cement enhanced the compressive strength of sandcrete block. Sandcrete blocks made with 1:6 mix proportion using 15% granite fines replacement gave optimum compressive strength of $4.11\ N/mm^2$.

Oyekan and Kamiyo (2008) investigated the performance of hollow sandcrete blocks containing cement, sharp sand and granite fines in varying proportions to determine their structural and hygrothermal properties. They varied the percentage of granite fines by volume of the total fine aggregate in steps of 5% to a maximum of 30%. Results of the tests showed that the inclusion of granite fines in the sand-cement matrix has a very significant effect on the compressive strength of sandcrete blocks. It was also observed that, for both mix proportions, 15% granite fines content was the optimum for improved structural performance. The hygrothermal properties of the block with 15% granite fines content indicated it as the most compact.

3.0 MATERIALS AND METHODS

3.1 Materials

The following materials were used in producing the sandcrete blocks used in this research work:

3.1.1 Sand

Clean sharp sand, free from waste stone and impurities were used in the production of the sandcrete blocks used in this research work.

3.1.2 Cement

Dangote brand of Ordinary Portland cement (OPC) of grade $42.5N/mm^2$ was used.

3.1.3 Water

Portable water which is free from suspended particles, salts and oil contamination was used throughout this study.

3.1.4 Quarry dust: The quarry dust was obtained from the Triacta's quarry site in Bauchi.

3.2 Methods

3.2.1 Mixing

In this study, the manual method of mixing was used. The cement and sand were mixed in a dry form and water was added in spray form in moderate proportions to allow the cement to hydrate and excess of water was avoided that would have caused shrinkage and distortion of block on drying. Water/cement ratio of 0.5 and mix ratio of 1:8 (one part of cement to eight part of sand) were adopted for this research work.

3.2.2 Compaction Methods

The blocks were compacted manually with the aid of a wooden rod. The blocks were of sizes 150 mm x 225 mm x 450mm

3.2.3 Curing

Curing was employed to maintain satisfactory moisture content and allow proper hydration and hardening of the sandcrete blocks. The blocks were cured by water spraying for the period of the 7, 14 and 28 days after which they were tested for compressive strength.

3.2.4 Determination of the Compressive Strength of Block Samples

The Compressive strength tests were carried out at the end of 7, 14, and 28 days of curing the sandcrete blocks using compressive testing machine. The test was carried out at the Concrete Laboratory of Federal Polytechnic, Bauchi, Bauchi State Nigeria. A total of Forty-five numbers of blocks were subjected to compressive strength test and the strength was computed using equation (1)

$$f_c = \frac{P}{A} \quad \ldots \quad (1)$$

Where: f_c= Compressive Strength (N/mm^2),

P = crushing load (kN), and

A = cross sectional area (mm^2).

3.2.5 Sorptivity and Porosity test

Sorptivity is the material property which characterizes the tendency of a porous material to absorb and transmit water by capillarity. The cumulative water absorption (per unit area of the inflow surface) increase as the square root of the elapsed time (t). The sorptivity is calculated using equation (2)

$$S = I/t^{1/2} \quad \ldots (2)$$

Where: S= sorptivity (mm)

T= elapsed time (mins)

I= $\Delta w/Ad$

Δw= change in weight= W_2-W_1

W_1= Oven dry weight of the sample

W_2= weight of sample after 30 mins capillary suction of water in grams

A= surface area of sample through which water penetrated

d= density of water

4.0 RESULTS AND DISCUSSION

4.1 Physical properties of the materials used

The physical properties of both aggregate (sand and quarry dust) were determined in accordance with BS 1377-9 (1990). These include: specific gravity, bulk density, water absorption and sieve analysis (Grain size distribution as shown in Fig 1 and Fig 2). Table 1 displays the physical properties of sand and quarry dust.

Table 1: Physical properties of materials used

Properties	Specific gravity	Bulk density(kg/m^3)	Water absorption	Particle size distribution
Sand	2.61	1460	0.19	Cu=4.5,Cz=0.47
Quarry dust	2.55	1796.30	0.24	Cu=10,Cz=1.11

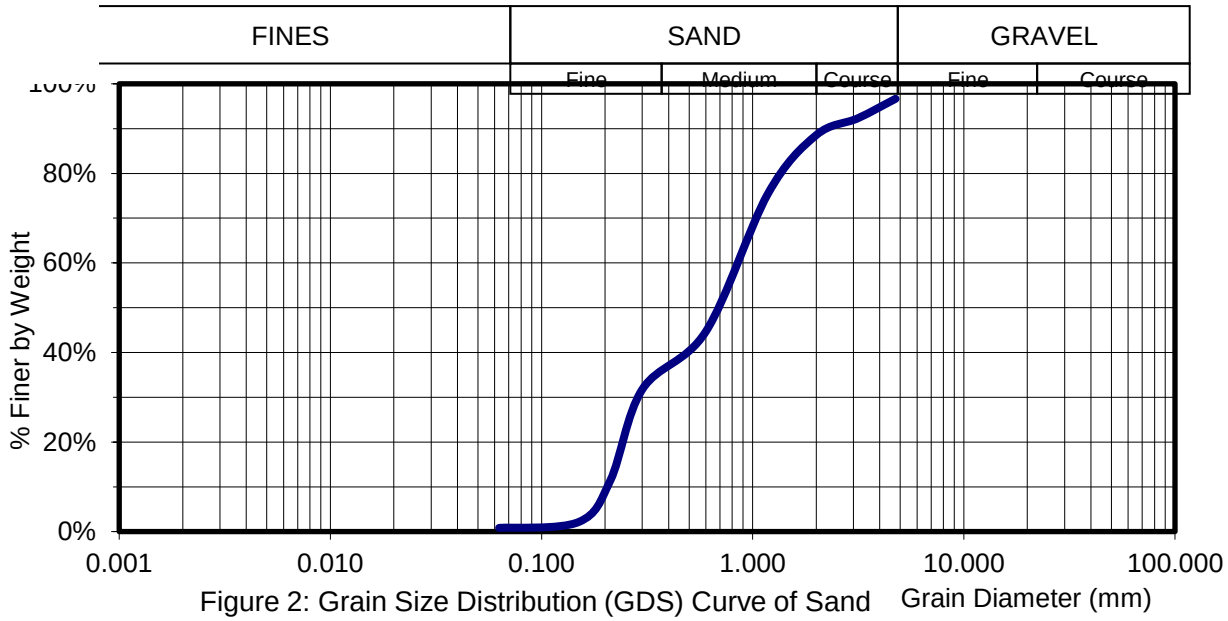

Figure 2: Grain Size Distribution (GDS) Curve of Sand

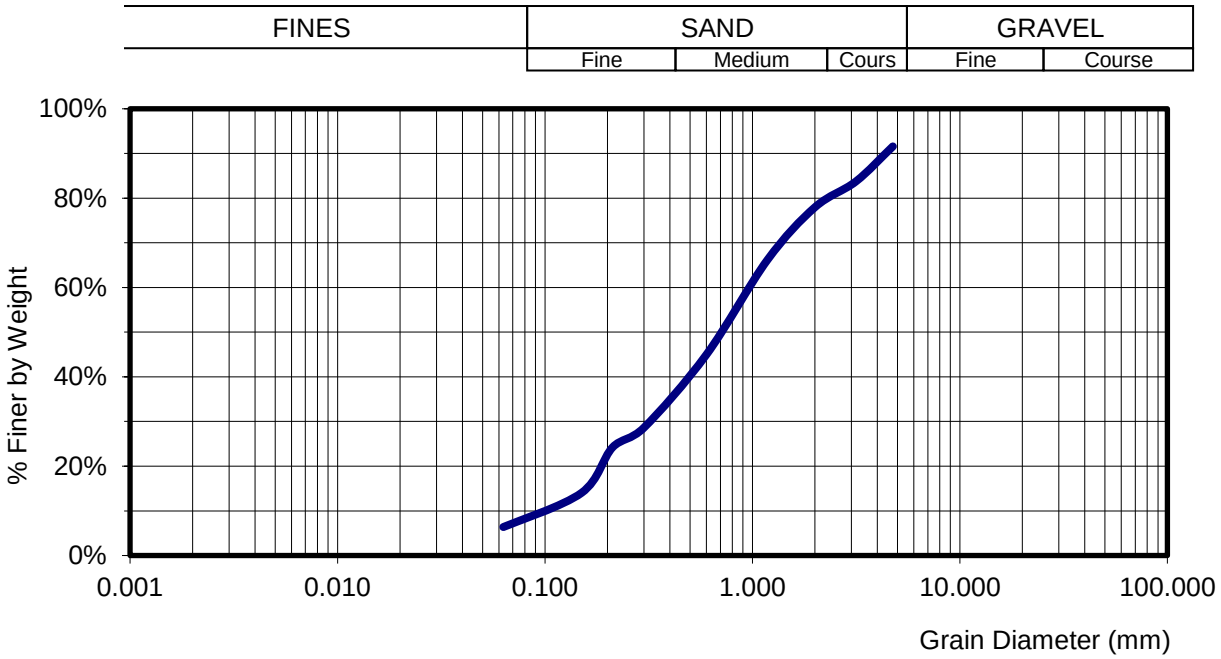

Figure 2: Grain Size Distribution (GDS) Curve of Quarry Dust

It was observed that, sand grains have higher specific gravity in contrast. Quarry dust has higher bulk density, because it contains little proportion of gravel. Quarry dust absorbs and holds more water due to presence of large proportion of fine sand. Particle size analysis reveals that quarry dust is well graded sand and the river sand is poorly graded.

4.2 Compressive strength

Results of compressive strength test are as presented in Figures 1 shows plots of average compressive strength against quarry dust percentage replacement for 7,14,and 28 days curing period. The result shows that addition of quarry dust to replace sand in sandcrete blocks improves the compressive strength. In addition, 15% partial replacement of sand by quarry dust yields optimum strength of 2.55N/mm^2 at 28 days, which is 37% increase in comparison to 0% replacement and meet the Nigerian Industrial Standard specification (NIS, 2000). Beyond 15% increase in quarry dust content reduces the strength of the sandcrete blocks. The maximum compressive strength at the age of 7and 14 days are 2.18 and 2.28 N/mm^2 respectively.

The enhanced strength obtained is perhaps due to better particle packing and the consequent reduction in the volume of the voids. Furthermore, the addition of granite fines improved the grading of the fine aggregate content thereby improving the workability of the mix and enhancing the compressive strength. This agrees with findings of Osuji and Egbon (2015), Olaniyan et al.(2012**)** and Oyekan and Kamiyo (2008).

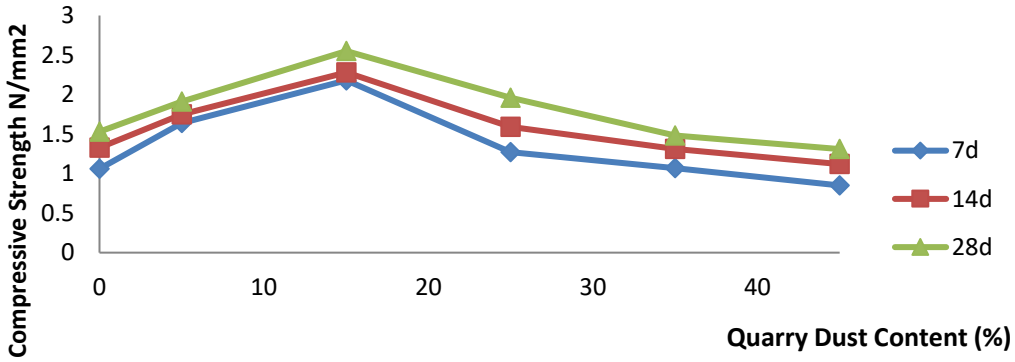

Fig.3: Variation of Compressive Strength and Quarry Dust content

4.3 Hygric Properties

For the hygric properties of the sandcrete blocks with fine aggregates partially replaced by quarry dust; the results of porosity and sorptivity are presented in Figure 4 and Figure 5.

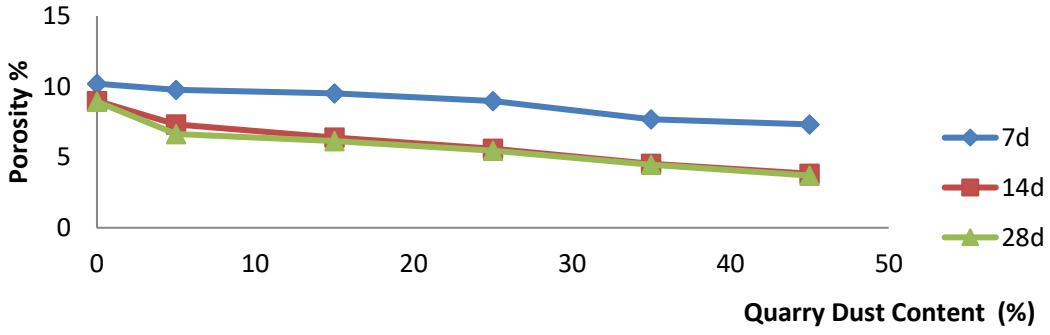

Fig.1.3 Graph of Porosity Vs Quarry Dust content

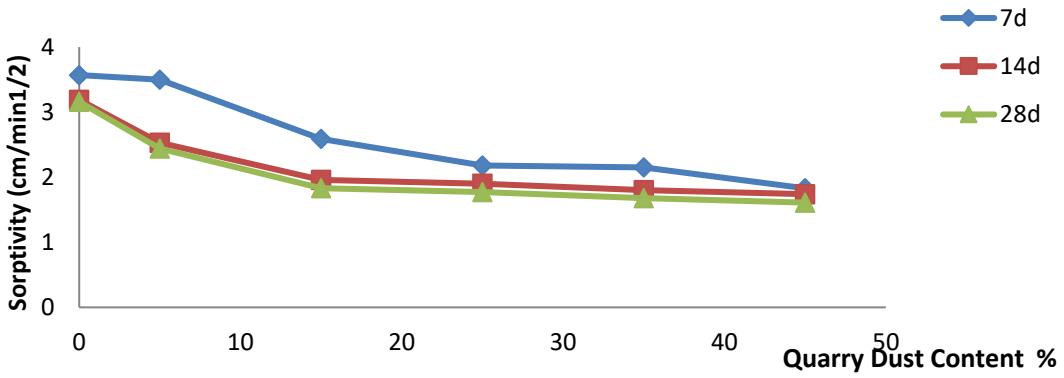

Fig.5: Variation of Sorptivity with Quarry Dust content

5.0 CONCLUSION

Based on the results obtained, the following conclusions were made:
(i) Quarry dust improves the compressive strength of the sandcrete blocks with an optimum strength at 15% quarry dust
(ii) Increase in quarry dust results in decrease in porosity and sorbtivity effects. At 15% granite fines content shows the most effective replacement for the structural performance.

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Assessment of Shredded Waste Poly-Ethylene Terephthalate (PET) Bottles Usage as Coarse Aggregate in Lightweight SHA Based Concrete Composite

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Abstract:
In this research report, the use of shredded waste Poly-ethylene Terephthalate (PET) bottle flakes as a lightweight aggregate in concrete was examined. Investigation was carried out on two groups of concrete samples, one made with only granite as coarse aggregate (control) and second made with PET and granite aggregate together as replacement for coarse aggregate. The PET replaced the granite coarse aggregate a varying percentage of 0%, 5%, 10% and 15%. Additionally, Sorghum Husk Ash (SHA) was also used as the replacement of cement on mass basis at the replacement ratio of 10% to reduce the amount of cement used and provide savings. The water–binder (w/b) ratio used in the mixtures were 0.55. The size of shredded PET flakes used in the preparation of concrete mixtures were between 1 and 4 mm. The results of the laboratory study and testing carried out showed that concrete comprising only granite aggregate, concrete containing PET and granite aggregate, and concrete modified with SHA as cement replacement can be drop into structural lightweight concrete category in terms of unit weight and strength properties. Therefore, it was concluded that there is a potential for the use of shredded waste PET as aggregate in the production of structural lightweight concrete. The use of shredded waste PET due to its low unit weight reduces the unit weight of concrete which results in a reduction in the self-weight of a structural concrete member of a building. Reduction in the dead weight of a building will help to reduce the seismic risk of the building since the earthquake forces linearly dependent on the dead-weight. Furthermore, it was also concluded that the use of industrial and agricultural wastes such as PET flakes and SHA in concrete provides some advantages, i.e., reduction in the use of natural resources, disposal of wastes, prevention of environmental pollution, and energy saving.

Keywords: *lightweight aggregate, Poly-ethylene Terephthalate (PET), Sorghum Husk Ash (SHA), Strength properties, Unit weight.*

INTRODUCTION

Lightweight aggregate is an imperative material in plummeting the density or unit weight of concrete to produce earthquake resilient constructions since the earth tremor forces are linearly reliant on the mass of the structure (Jafari & Mahini 2017, Semiha et al., 2010). The use of Lightweight aggregates is largely meant for the reduction of the unit weight of concrete through substituting the conservative aggregates. Currently, there are numerous lightweight concrete submissions made with natural or artificial lightweight aggregates in the literature (Saikia et al. 2014, Islam et al. 2016, Madandoust et al. 2019, Ashrafian et al. 2020, Záleská et al. 2018). Though, the cost of non-natural lightweight aggregate production is high owed to necessity of high burning temperature or thermal treatment (Semiha et al. (2010). Consequently, unlike other common materials, using waste plastic pellets as lightweight aggregate in the manufacture of lightweight concrete has engrossed considerable interest and keen devotion from the researchers. This method offers both recycling of the plastic waste and manufacture of a lightweight concrete in an cost-effective manner (Hilal et al., 2021, Koide et al., 2002).

Poly-ethylene Terephthalate (PET), Polypropylene (PP), and Polystyrene (PS). Poly-ethylene (PE) are some of the plastic wastes used in lightweight concrete. The PET bottles are ahead of the wastes with its high growing speed of consumption. PET excels by its inherent values like strength, safety, cost-effectiveness and being lightweight, unbreakable and recyclable. Today, the food and beverages industry is increasingly using PET (polyethylene terephthalate) to replace glass and other materials. In Nigeria, the usage of PET started in a noticeable way only

very recently. It is projected that the demand will grow appreciably, especially for packaging soft drinks and water. Research indicates that the main driver of growth for PET (polyethylene terephthalate) bottles in Nigeria has been the food and beverage sector with water industry accounting for about sixty-five percent (65%) of PET (polyethylene terephthalate) usage in Nigeria (Foraminifera Market Research, n.d, Tuleun & Jimoh, 2018).

As a result of wild increase in the usage of PET bottles in our environment, solid waste problem is upstretched and over a hundred of years is required to degrade the waste PET bottles naturally (Ioakeimidis et al., 2016, Pol 2010). Hence, one of the realistic approaches for disposal of PET wastes, which causes environmental pollution, is using these wastes in the other manufacturing expanses, thus recycling the PET for beneficial, ecological and economic purpose. Several experimental studies have been carried out on using waste PET bottles as resin in polymer concrete and as fibre in fibrous concrete in recent years (Asdollah-Tabar et al., 2021; Patil et al., 2020; Batista et al., 2021; de Luna et al., 2020; Alani et al, 2020). Nevertheless, the utmost cost-effective use of waste PET bottles in concrete as being described by researcher to be shredded waste PET bottles used directly as aggregate in concrete fabrication. Thus, the use of PET wastes as aggregate in concrete will afford benefit in the disposal of wastes and reduce the environmental damages owed to the use of natural mineral aggregates resources (Semiha et al., 2010). Limited study on concrete fabricated with waste PET flakes as coarse aggregate are reported in literature (Islam et al. 2016; Saikia and de Brito, 2014; Silva et al., 2013; Ghaly and Gill, 2004). Though, besides waste PET, other plastic wastes such as HDPE, PE and PS have been used as aggregates in preparing various concrete composites (Naik et al., 1996). Plastic bottles shredded into PET flakes and pellets may be used successfully as substitution for coarse aggregates in cementitious concrete composites and be used for structural concrete member.

In addition, SHA was used as a replacement of cement in concrete in previous studies. It is reported in many investigations that, the use of SHA in concrete as a cement replacement has positive influence on the properties of the fresh and hardened concrete (Ndububa & Nurudeen, 2015; Tuleun & Jimoh, 2018). In addition, it also provides economic benefits (Tuleun & Jimoh, 2018). It improves strength, reduces permeability and porosity, reduces alkali-silica expansion of hardened concretes (Ogork and Danja, 2018; Tijani, et al., 2019a; Tijani et al., 2019b). 10% SHA replacement level was reported as the optimum quantity for achieving a competitive value for compressive strength of resulting concrete (Ndububa & Nurudeen, 2015). Thus, in this research, SHA was also employed as a partial cement replacement to attain savings from the amount of cement used in the manufacture of lightweight concrete made with lightweight PET aggregates. The usage of SHA in concrete affords ecological advantages apart from the energy savings and contribution to the properties of strength and durability of concrete (Tuleun & Jimoh, 2018).

This study, hence, investigated the performance of lightweight concrete produced using SHA as the supplementary cementitious material and waste PET bottle, which partially replaced the mineral aggregates as coarse aggregate in varying percentage to optimize the most suitable quantity of PET for a structural light weight concrete. This is achieved by examining the physical and mechanical properties of concrete containing PET aggregates.

MATERIALS AND METHODS

In this study Portland cement (CEM 1 42.5N - Dangote 3X) produced by Dangote Cement Company was used as the binder for the control reference concrete mix. The Portland cement used as binder for both control reference concrete mix and blended mix in this research was

1 cement (90%) and SHA (10%) binder were 115 mins and 230 mins respectively. The specific gravity of the cement used was 3.15 g/cm3 and Blaine specific surface area was 3220 cm2/g.

Sorghum Husk used was gotten from a farm waste dump in wukara village of kyami district, FCT-Abuja, Nigeria. At first, the collected Sorghum Husk was treated by drying and screening to eliminate unwanted leaves and straw constituents. The treated Sorghum Husk were afterward burned in open air using a locally fabricated incinerator described in the literature (Abalaka and Okoli, 2013). The resulting Sorghum Husk Ash (SHA) was sieved to remove extraneous and unburned carbon materials. Ensuing, the resultant SHA particles were ground to sizes below 150 µm using a local milling device. Finally, the pulverized ash was sieved to 75 µm particles to obtain the SHA used for the subsequent experiments.

The specific gravity of SHA was 2.30 g/cm^3 and Blaine specific surface area was 4210 cm^2/g. The BET value for SHA was determined as 3.420 m^3/g. If the particles are porous, or have a rough surface structure, the BET surface area will be greater than the Blaine surface area. For this SHA particle, the particle was determined not to be porous. Blaine fineness along with chemical reactivity of cementitious or fine particles materials composition and fineness controls early strength development. Actually, most Type III cements today are simply higher fineness types of the regular Type I, II or V cement formed at the same plant. The chemical composition of cement and SHA are given in Table 1.

Table 1: Chemical composition of Portland Cement (CEM 1) and Sorghum Husk Ash (SHA).

Oxides (%)	NaO	MgO	Al_2O_3	SiO_2	P_2O_3	K_2O	CaO	TiO_2	MnO	Fe_2O_3	SO_3	LOI
CEM 1	0.10	1.24	6.12	21.3	0.05	0.23	65.0	0.25	0.01	3.47	1.02	0.80
SHA	0.45	2.05	20.10	60.25	0.15	2.45	0.76	1.16	0.30	10.89	2.38	5.76

The shredded waste PET bottle flakes used as aggregate were supplied from Sarz Gen enterprise, a waste plastic recycled plant, in free trade zone, Sharada, Kano state, Nigeria. It was got by picking-up waste PET bottles and washing, then crushing into flakes by machines. The average maximum size of PET aggregate was 4 mm, and its specific gravity was 1.35 g/cm^3. River sand with maximum size of 4.75 mm was used in this study. The absorption value of the sand was 1.33% and, the relative density at saturated surface dry (SSD) condition was 2.62 g/cm^3. The grading of sand measured according to ASTM C33 (2019) showed that the present sand can be used in concrete production.

Mix proportions, sample preparation and testing methods

The water–binder (w/b) ratio used in this work was 0.55. CEM 1 Cement and SHA were used as the binder. SHA was used as a partial replacement of cement on weight base at the replacement ratio of 10%. Waste shredded PET flakes were used as substitution to coarse aggregate (crushes granite) in varying percentage of 0%, 5%, 10%, 15% and 20% in the M (1-5) and S (1-5) mixtures. M (1-5) signifies mixture without SHA content, while S (1-5) mixture is the concrete produces with 10% blended cement mix. The proportions of concrete mixtures are given in Table 2.

Cubical and cylindrical specimens with 100 x 100 x 100 mm and 100 x 200 mm dimensions respectively were prepared from fresh concrete mixtures. They were afterwards demoulded after 24 hours and immediately cured in water at 22 ± 2^{o}C for 7, 28 and 56 days (ASTM C192/C192M (2007). The samples were tested for compressive strength and tensile strength. In addition, slump test and the fresh unit weights test was conducted on the fresh concrete mix in accordance with the British Standards (BS EN 12350-2 (2009). While the dry unit weights

test, was conducted on the hardened specimen. The compressive and tensile strength values of concrete specimens were measured by using the test methods according to (BS EN 12390-3, 2009 and ASTM C496/C496M, 2011). All testing measurements were obtained from three samples, and the average of three samples was presented and discussed in the study.

Table 2: The proportions of concrete mixtures by weight (%).

Mix ID	SHA (%)	PET (%)	SHA (kg/m^3)	CEM 1 (kg/m^3)	PET (kg/m^3)	Coarse Aggregate (kg/m^3)	Fine Aggregate (kg/m^3)	Water (kg/m^3)	SP (1%)
M1	0	0	0	404.26	0.00	1189.54	578.01	215.72	4.04
M2		5	0	404.26	59.48	1130.06	578.01	215.72	4.04
M3		10	0	404.26	118.95	1070.60	578.01	215.72	4.04
M4		15	0	404.26	178.43	1011.11	578.01	215.72	4.04
M5		20	0	404.26	237.91	951.63	578.01	215.72	4.04
S1	10	0	40.43	363.83	0.00	1189.54	578.01	215.72	4.04
S2		5	40.43	363.83	59.48	1130.06	578.01	215.72	4.04
S3		10	40.43	363.83	118.95	1070.60	578.01	215.72	4.04
S4		15	40.43	363.83	178.43	1011.11	578.01	215.72	4.04
S5		20	40.43	363.83	237.91	951.63	578.01	215.72	4.04

RESULTS AND DISCUSSION

Unit weight

Measured fresh unit weights and dry unit weights of concrete specimens at 7, 28 and 56 days are presented in Table 3. The fresh unit weights of M1-M5 and S1-S5 where M1 is mix without SHA and PET and S1 is mix containing 10% SHA and 0% PET which are the control samples. The mix proportions were presented in Table 2. The dry unit weights of all specimens decreased in course of time due to the evaporation of free water and as the due to the increase in percentage of the Pet in concrete due to the increase of the pore structure. The dry unit weight at 28 days hydration period values of concrete without SHA (M1-M5) and (S1-S2) were between 1138 m^3 and 2243 kg/m^3. The unit weight of M1-M5 is lower than the unit weight of S1-S2. Since the specific gravity of SHA was lower than CEM 1 cement as the binder, the dry unit weights of the concrete made with PET were lower than the concrete without PET (M1 and S1) serving as the control sample.

The relationship between the workability (slump) and the percentage replacement of the PET aggregate is displayed in Table 3. The slump value of both PET concrete containing 10% SHA by weight of cement and without SHA declines as the percentage replacement of the PET aggregate rises, as revealed in Table 3. The declining ratios of workability indicate 89.5%, and 94.7% in comparison with that of normal concrete at the percentage cement replacement ratio of 0%, and 10%, respectively. This may be attributed to not only the smooth shape of the PET but also to the absorption and hydrophilic property of SHA. The workability reduction experienced by the light weight concrete is due to the large surface area of the ash and the smooth surface of the PET. PET and SHA is capable of reducing the unit water content and the water-reducing agent content. It is expected that the reduction of the unit water content could compensate for the strength reduction of the PET/SHA concrete in the case of manufacturing the concrete with the same slump.

Table 3: Fresh and dry unit weights (kg/m^3) of concrete produced.

Mix ID	SHA (%)	PET (%)	Fresh Unit weight (kg/m^3)	Dry Unit weight (kg/m^3)			Slump (mm)
				7	28	56	
M1	0	0	2383.98	2254	2243	2201	95
M2		5	1915.72	2085	1831	1839	60
M3		10	1884.19	1965	1810	1847	50
M4		15	1855.44	1792	1744	1656	35
M5		20	1821.28	1557	1503	1453	10
S1	10	0	2316.23	2174	2115	2046	80
S2		5	1896.84	1847	1808	1745	55
S3		10	1853.39	1802	1766	1662	45
S4		15	1818.22	1744	1482	1384	25
S5		20	1781.74	1254	1138	1058	5

Compressive strength

Structural lightweight concrete is defined by ACI Committee, as the compressive strength of 28 days, which is higher than 15–17 N/mm^2. ACI Committee also opined that the air-dry unit weight of a structural lightweight concrete should be lower than 1850 kg/m^3 (ACI Committee 213R, 1987). The air-dry unit weights of the ten mixtures presented in Table 3 were lower than 1850 kg/m^3; in other words, they complied with the above definition in terms of unit weight. The compressive strength values of concrete measured in the laboratory are presented in Table 4. Table 4 shows that the compressive strength values at 28 days of the concrete specimens were quite higher than 17 N/mm^2. When the unit weight and compressive strength values are considered together, M1-M5 and S1-S5 mixtures can be classified as a structural lightweight concrete

The 28 days compressive strength values of the mixtures containing only PET aggregates (M2-M5) were 33.28, 29.55, 26.27 and 23.40 N/mm^2. These values reached 36.76, 32.22, 30.48, 25.91 N/mm^2 at 56 days, respectively (Table 4). The compressive strengths of S2-S5 mixtures (including PET and SHA together) were 32.90, 26.50, 25.98 and 21.33 N/mm^2 at 28 days. At 56 days, their levels raised to 37.93, 34.11, 31.87 and 27.11 N/mm^2, respectively (Table 4). It was seen from these results that, the compressive strengths of the mixtures containing 10% SHA and varying percentage replacement of PET together were higher than the mixtures containing varying percentage replacement of PET without SHA at 56-day hydration period. This was an expected result. Nonetheless, the compressive strength values of PET aggregates with SHA blends (S2–S5) were found to be suitable. The compressive strength values of typical control normal weight concrete mixture (M1) which is set for evaluation purposes were 18.43, 32.54 and 34.35 N/mm^2 at 7, 28 and 56 days, respectively (Table 4).

It can be seen from Table 4 that the compressive strengths of concrete produced in this investigation developed rapidly at an early age up to 28 days, however, after 28 days the speed of compressive strength developments slowed down in long term (56 days). This result was found to be similar to the strength development of normal weight mortar.

It can be observed from Table 4 that, in general, the compressive strength of the concrete modified with SHA as cement replacement corresponding in pattern with the compressive strength of the cement concrete at 7 and 28 days. After that, they passed the compressive strength of concrete made with only cement as the binder. Replacement of cement with SHA increased the compressive strength of concrete when compared to strength of concrete made with cement only especially at 56 days.

Table 4: Compressive strength (N/mm^2) of concrete produced.

Mix ID	SHA (%)	PET (%)	Compressive Strength (N/mm^2)			Tensile Strength (N/mm^2)		
			7	28	56	7	28	56
M1	0	0	18.43	32.54	34.35	2.05	3.85	3.98
M2		5	16.84	33.28	36.76	1.46	3.73	3.88
M3		10	14.65	29.55	32.22	1.36	3.34	3.57
M4		15	12.91	26.27	30.48	1.12	2.91	3.37
M5		20	10.44	23.40	25.91	0.73	2.39	3.13
S1	10	0	14.44	31.20	34.96	1.69	3.70	4.18
S2		5	13.22	32.90	37.93	1.25	3.56	3.94
S3		10	11,39	26.50	34.11	1.12	3.38	3.74
S4		15	10.16	25.98	31.87	0.71	3.22	3.62
S5		20	8.49	21.33	27.11	0.34	3.04	3.44

This could be seen from Table 4 that strengths development of S2 to S5 were better than the strength developments of M2 to M5 for concrete with age 56 days. It was explained in the literature that, the strength of concrete modified with Supplementary Cementitious Materials (SCMs) as cement replacement was lower than the strength of NPC concrete at early ages (Semiha *et al*., 2010). However, when it was cured adequately, its strength could be equivalent or higher than the control concrete in long term (Fernandez and Malhotra, 1990; Yeau and Kim, 2005; Bilim, 2006; Yazici, 2006; Oner and Akyuz, 2007). The result observed in this study for SHA concrete was found to be in-agreement with the literature.

Splitting tensile strength

The effect of substituting granite aggregate with waste bottle PET flakes at varying percentage with various w/c ratios is presented in Table 4. As illustrated in table 4, the general trend of tensile strength is decreasing when the amount of PET particles increases. For instance, for the both concrete mix without SHA (M2-M5) and concrete mix with 10% SHA, reduction occurred in tensile strength. This can be attributed to the negative effect of the smooth surface texture of the PET flakes on the bond strength between the PET, matrix and the aggregates. The increase surface area of PET particles compare to granite coarse aggregate is also a factor to consider. In addition, as the PET ratio increases, the reduction in splitting tensile strength is more significant.

Conclusions

The following conclusions were made from this experimental work:

i. Concrete containing only PET aggregate and concrete modified with SHA as cement replacement produced in this study drop into structural lightweight concrete category.

ii. The use of SHA reduced the slump and both wet and dry unit weight of the specimens. It also increased the compressive and tensile strength of the samples.

iii. The compressive and tensile strength values of the concrete containing PET and SHA together were higher than the concrete containing only PET aggregates.

iv. Based on the experimental study, the use of shredded waste PET flakes in concrete has a potential to reduce the dead weight of concrete, thus, can reduce the earthquake risk of a building, and it could be helpful in the design of an earthquake resistant building.

v. The usage of industrial and agricultural wastes such as shredded waste PET flakes and SHA in concrete production would be helpful and resourceful in solving a part of the world present day environmental concern, in reduction and recycling plastic waste which has become a menace to the environment and also for achieving a cleaner environment and reduce the depletion of the ozone layer and energy saving.

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Characteristics and Properties of Rice Husk Ash Based Fibrous Concrete Manufactured with Waste Metallized Plastic Film Fibre

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Abstract
The promotion of the use of eco-friendly substitutes to cement by several stakeholders in the construction industry are on the increase. This is due to the record portraying the cement and concrete industry as one of the largest producers of greenhouse gas globally. In order to reduce the waste generated globally, industrial and agricultural waste have been reported to enormous potential for reducing global cement reliance. One exciting material that has attained this feasibility is rice husk. The advancement in concrete technology in most recent times tends to deduce the potential means available for the optimum recycling of waste materials in construction practices for the purpose of sustainability in construction. In this article, effect of Waste Metallized Plastic Film (WMPF) fibre on the compressive and tensile properties of Rice Husk Ash (RHA) based Fibrous Concrete (FC). Mixes containing varying percentage of WMPF fibre (0%, 0.5% and 1.0%) were made with and without RHA to produce FC. The laboratory test revealed that the combination of WMPF fibre and RHA decreased the slump values and increased the VeBe time of fresh concrete. Similarly, the inclusion of WMPF fibre, either into CEM 1 cement or RHA concrete, did not improve the compressive strength. However, the positive interaction amongst the WMPF fibre and RHA lead to higher splitting tensile strength. It was revealed from the tensile test failure mode that WMPF fibre act as bridges across the cracks, which improved the load-transfer capacity of the matrix. The study showed that the utilization of WMPF fibre and RHA in the production of concrete is achievable from both technical and environmental viewpoints.

Keywords: *compressive strength, fibrous concrete, rice husk ash, tensile strength, waste metallized plastic film fibre*

1. INTRODUCTION

Waste management is a vital process towards enhancing the well-being of a nation. The world in general has been in extreme clamor to see in vivid terms an effective strategy formulated to enable the control of wastes and avert its effects on the general public. The exploitation of waste materials is one of the fundamental matters of waste management strategies in many parts of the world. The benefits of recycling comprise reducing environmental pollution, plummeting landfilling and discarding of wastes and conserving natural resources (Awal et al., 2015; Hossein and Mahmood, 2018). Mechanization and technological inventions produce huge amounts of waste materials from pre- and post-consumers products every year. In the construction industry, the knowledge of sustainability emboldens the use of waste products to substitute raw materials, such as fine and coarse aggregates, cement and fibrous materials. This leads to sustainable, green and environmentally friendly construction by decreasing the price of the constituents likened to disposing of the materials. Concrete is the utmost imperative construction material and its consumption is growing all around the globe. In addition to the normal applications, higher tensile strenth, ductility and energy absorption capacity are time and again required in different bids like runway, industrial floors, highway paving and bridge decks.

Cements are usually classified as calcium silicate and calcium aluminate cement. Calcium silicate cement is further classified into Portland and Slag, while calcium aluminate is classified into High alumina and Pozzolona cement (Jackson and Dhir, 1991). Rice Husk Ash (RHA) has

been recognized as pozzolan. A pozzolan is a siliceous/aluminous material which in itself has little or no cementitious value, but which will in finely divided form and in the presence of moisture, chemically reacts with calcium hydroxide liberated during the hydration of Portland Cement (PC) to produce stable, insoluble cementitious compound which contributes to its strength and impermeability (Sima, 1974). Addition of RHA to PC does not only improve the early strength of concrete, but also forms a Calcium Silicate Hydrate (CSH) gel around the cement particles which is highly dense and less porous, and may increase the strength of concrete against cracking (Saraswathy and Ha-Won, 2007). The chemical analysis of the RHA revealed high amount of silica, alumina and oxides such as calcium oxide and iron oxide responsible for strength, soundness and setting of the concrete. It also contained some amount of magnesia which is responsible for the unsoundness (Saraswathy and Ha-Won, 2007).

The study of Nagrale *et al.* (2012) reported that addition of 15% RHA influences the density of concrete by reducing the weight concrete to about 72-75%. Thus, RHA concrete can be effectively used in the production of light weight concrete for the construction of structures where the weight of structure is of supreme importance. Nagrale *et al.* (2012) study further explained that the Compressive Strength of concrete will increase with the addition of RHA and noted that the inclusion of RHA in concrete considerably reduces the water absorption of concrete. Thus, concrete containing RHA can be effectively used in places where the concrete can come in contact with water or moisture. RHA has the potential to act as an admixture, which increases the strength, workability & pozzolanic properties of concrete.

Hossein and Mahmood (2018) reported that Plain unreinforced concrete is a brittle material, with a low tensile strength and a low strain capacity. Due to the lack of tensile strength in concrete, it is reinforced with bars in structures. But this kind of reinforcement is crude and ineffective for crack control. Also this reinforcement gets decayed and corroded when exposed to the environments. The roles of randomly distributed discontinuous fibres is to bridge across the cracks and provide some post-cracking ductility. If the fibres are sufficiently strong and efficiently bonded to the material then it will permit the concrete to carry significant stresses over a relatively large strain capacity in the post-cracking stage (Saraswathy and Ha-Won, 2007).

Hossein and Mahmood (2018) stated that concrete mixtures of Waste Chopped Metallic Film (WCMF) fibre with 20% POFA produce a decreased compressive strength of 13.5% at 7 days and 10.2% at 28 days curing when compared to that of the PC-based concrete mix. However, at the curing period of 91 days, POFA based fibrous concrete mixtures attained compressive strength values higher than that of OPC-based mixtures.

Besides the workability properties, the aspects of strength properties are measured in the valuation of performance and possible application of any new waste material in concrete composites. Hitherto and to the authors' knowledge, there is no literature on the strength properties of WMPF fibre concrete composites containing RHA. Considering the pozzolanic behavior of RHA as well as the availability of WMPF fibres, studies on the application of the supposed materials in concrete were carried out in the Department of Building, Federal University of Technology Minna (FUTMINNA), Niger State, Nigeria. In view of that, the drive of this study was to utilize RHA as a supplementary cementing material in WMPF fibre concrete composite. Beside the fresh concrete properties, the strength properties such as compressive and tensile properties were tested and related with that of PC fibreless concrete. This attempt on using WMPF fibres and RHA in concrete composites could be cost-effective and environmental friendly as it limits the exploitation of virgin and natural resources that leads to the depletion of the earth surface. Also, the utilization of WMPF fibres and RHA in concrete

production as the potential of decreasing landfilling problems in our environment in order to achieve a cleaner environment and inclusive cleaner production in the construction industry.

2. EXPERIMENTAL PROGRAM

This study focuses on the workability, compressive and splitting tensile strength of WMPF fibre reinforce concrete containing RHA. Mix designs of the fibre reinforced concrete with the different percentage of WMPF fibre and 15% RHA were developed. Slump test and vebe test was conducted to measure the workability of the mix designs. Upon preparation of the RHA base WMPF fibre reinforced concrete samples, they were cured in water for different ages of 7, 28 and 56 days. Compressive strength test and tensile strength test was conducted to measure the strength properties of the RHA base WMPF fibre reinforced concrete.

2.1 Materials

The materials used was placed in dry environment and air dry naturally. The detailed description of each material that was used in this study is discussed below:

The rice husk were collected from Grain mill in Dama, Bosso Local Government of Niger State. The husk was dried and burnt in open air to get the ash which act as the pozzolan in the concrete material. The cascinated RHA was sieved to remove impurities after which it was grinded to a finer form and finally sieved using a 75µm sieve (Figure 1a). The specific gravity of the RHA is 2.51. RHA was used to replace the portland cement at a constant percentage of 15%. Figure illustrate a sieved RHA material. The obtained RHA is in consonance with the provisions of BS 3892: Part 1 (1997). According to ASTM C618 (2015), RHA can be characterised as class C and F. However, based on the type, source and comparatively low CaO (1.25%) content, this ash was classified as low calcium content ash. The chemical compositions of RHA are given in Table 1.

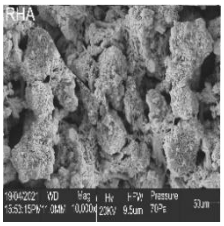
Table 1: Physical properties and chemical compositions of RHA

Chemical composition (%)										
Binder	**SiO_2**	**Al_2O_3**	**Fe_2O_3**	**CaO**	**P_2O_5**	**MgO**	**K_2O**	**TiO_2**	**Mn_2O**	**LOI**
PC										
RHA	83.79	0.54	1.38	1.26	6.29	1.55	1.56	0.20	0.29	2.93

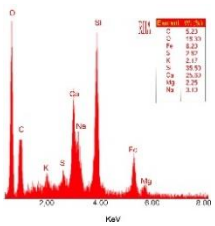
The Scanning Electron Micrograph (SEM) of RHA is presented in Figure 1(b). The SEM micrograph of the RHA showed marginal pores at the magnification of ×10,000. The pore opening sizes could affect the workability of fresh concrete since it would mean a propensity to engross water. It could also affect the number of voids and capillaries, thus plummeting the density of the packed structure. Figure 1(b) showed that the RHA comprises spherical particles with a smooth surface.

The EDS analysis (Figure 1c) showed that the predominant elements in the tested RHA sample were; Si, Ca, and O in various compounds, although lower amounts of the elements Mg, S, K, Na, C and Fe were also observed.

(a)



(b)



(c)

Figure 1: (a) Calcined RHA photo (b) SEM image (c) EDS image (d) XRD pattern of the RHA sample used in the study

The fibres used for this work is the Metallic Plastic Film (MPF) used for packaging of beverage such as Peak Milk (Figure 2a). The WMPF were sought out for around the environment of the study area, since it's a readily available plastic waste common in student residence environment. The WMPFF were chopped into smaller piece of 20 mm length by 2 mm width as illustrated in Figure 2(b&c). Table 2 shows the Engineering properties of WMPF fibre.

Table 2: *Engineering properties of WMPF fibre.*

Property	Values
Resin category	Polypropylene
Plastic type	LDPE
Thickness (mm)	0.07
Size (W*L) (mm)	2 x 20
Density range (kg/m3)	0.915–0.945
Tensile strength (MPa)	400
Elongation (%)	8–10
Reaction with water	Hydrophobic

Source: Hossein & Mahmood (2018).

(a) Post-consumer waste metalized plastic films (b) fabricated metalized plastic fibres (c) WMP fibres used in this study.

Figure 2: Waste metalized plastics fibres

The cement used was a Nigerian based brand of Portland cement (PC) with 28 days strength of 52.5 MPa. The specific gravity of the Portland cement is 3.15. ASTM Type 1, with brand name Dangote Portland cement, Portland cement is a hydraulic material, when mixed with water; it results in formation of exothermic bonds. The fine aggregate used for the production of the concrete is collected from a local river sand and it has a maximum sieve size of 4.75 mm with a specific gravity of 2.64 was used as the fine aggregate. Coarse aggregate used was crushed granite with a maximum sieve size of 10 mm and a relative specific gravity of 2.7. The water used for preparing and curing concrete was collected from a Bore hole supply in the School of Environment Technology, Department of Building laboratory. Superplasticiser (SP) of trade name CONPLAST SP 430 conforming to ASTM C494 (2018) requirement was used as a water reducing admixture to enhance the workability of the fresh concrete. Owing to the high viscosity, the super plasticiser was added to the mixing water. CONPLAST SP 430 is a high range water-reducing concrete admixture. It is a highly effective dual action liquid super plasticiser for the production of free-flowing concrete or as a substantial water reducing agent for promoting high early and ultimate strength. It is chloride free and is compatible with all types of Portland Cement.

2.2 Mix Proportion and Sample Preparation

The concrete mix proportions were designed in accordance to the appropriate provisions of the Department of Environmental (DOE) methods of concrete mix design manual. To show the authentication of the determined mix design carried out, trial mixes tests were carried out to obtain the suitability of the mix and to ensure that concrete is produced with respect to the desired fresh concrete characteristics. RHA based fibre reinforced concrete suitable mix design and appropriation mixing procedure were developed after several trial mixes had been done. Table 3 shows the values obtained from the mix design prepared. Different mix proportions of PC-based concrete and RHA-based concrete composites are given in Table 3.

Several mixes with different fibre volume fractions were prepared, of which one batch was made of PC type cement without any fibre content, and also RHA based concrete of 15% replacement without fibre which was assumed as the control mix. There were four batches which includes mixes containing fibre contents of PC based concrete with WMPF fibres content of 0, 0.25, 0.50, 0.75, and 1.0%. The other four mixes, which are referred as group of RHA, were prepared by replacing PC cement with 15% RHA with the addition of the corresponding WMPF fibre contents as stated above.

Table 3: *Mix proportion details of concrete constituent*

Mix Type	Mix ID	Cement (Kg/m^3)	RHA (%)	RHA (Kg/m^3)	Water (Kg/m^3)	Fine Aggregate (Kg/m^3)	Coarse Aggregate (Kg/m^3)	V_f (%)
Group A	PC	521	0	0	250	784.5	784.5	0
	PF1	521	0	0	250	784.5	784.5	0.5
	PF2	521	0	0	250	784.5	784.5	1.0
Group B	R1	442.5	15	78.2	250	784.5	784.5	0
	RF1	442.5	15	78.2	250	784.5	784.5	0.5
	RF2	442.5	15	78.2	250	784.5	784.5	1.0

Note: PC=Plain concrete, R1=RHA based concrete with 15% replacement of cement, PF1=Cement + Aggregate+ WMFF of 20mm length at 0.5% addition, PF2=Cement + Aggregate + WMPF fibre of 20mm length at 1.0% addition, RF1= RHA based concrete at 15% of cement replacement + WMPF fibre of 20mm length at 0.5% addition and RF2= RHA based concrete at 15% of cement replacement + WMFF of 20mm length at 1.0% addition.

2.3 Test Methods

The workability investigation carried out on the fresh concrete mixture are slump test (BS EN 12350-2, 2009) and vebe time test (BS EN 12350-3, 2009). 100 mm x 100 mm x 100 mm cube specimen were used to determine the compressive strength of the concretein conformity to BS EN 12390-3 (2009). Cylinderical specimen of 100 mm diameter and 200 mm height was used to carryout splitting tensile strength which conforms to ASTM C 496 (2011) at the curing periods of 7, 28 and 56 days.

3. RESULTS AND DISCUSSION

3.1 Workability

The influence of RHA and WMPF fibres on the consistency of concrete composites was investigated using the slump and VeBe time tests and the results are presented in Figure 3&4. It was observed that the workability of fresh mixtures is significantly influenced by WMPF fibres and RHA. It was found that the addition of WMPF fibre in the concrete mixtures caused decrease of slump values and an increase of VeBe times. The inclusion of WMPF fibres affects the viscosity of the matrix. The addition of fibres at higher volume fraction also interjects the consistency of the mixture, which was directed to the balling effect of concrete components

and WMPF fibres. As demonstrated in Figure 3, the slump value of the control mixture (0% RHA/%Fibre content), was recorded as 180 mm. By the addition of WMPF fibre at volume fraction of 0.25%, 0.5%, 0.75% and 1%, the slump values reduced to 125, 85, 60, and 50 mm, respectively. Furthermore, the addition of RHA into the mixtures would make the matrix denser by filling up the micro-pores in the mixture, as stated by Mohammadhosseini *et al*. (2017), and Sata et al. (2007). Consequently, it caused a stiffer mixture with a corresponding decrease in the flowability of the matrix. From the experimental findings, it was evident that the addition of 15% RHA added into the mixture, made the slump values reduced to 165 mm and VeBe time increased to 17 seconds compared to that of 180 mm and 16 seconds for Portland Cement control mixture (0% RHA/0% Fibre) (Figure 4). Increased fibre volume fractions in RHA-based mixtures also contributed to the reduction in workability of concrete composites. For example, the slump values of 110, 60, 45, and 40 mm were recorded for the similar fibre content, respectively. For a given fibre volume fractions, the addition of a constant amount of RHA lead to higher VeBe times as well. The reduction in the workability of the RHA-based mixtures could be attributed to the high surface area, high porosity of RHA particles in addition to the high water absorption physiognomies of RHA as likened to other pozzolanic materials such as fly ash. On the other hands, as RHA is an agriculture waste and contains carbon and unburned particles, these particles absorb superplasticizer and water, and therefore, decrease the workability of concrete, as reported by Khankhaje et al. (2016) and Sata et al. (2007).

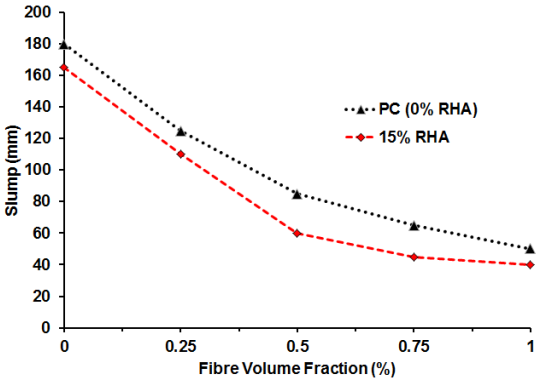


Figure 3: Effects of WMPF fibres on slump values of concrete containing 0% RHA and 15% RHA.

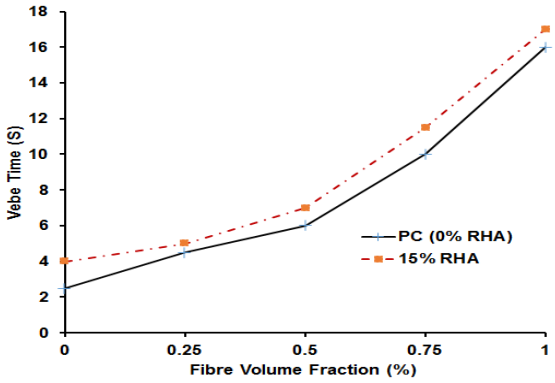


Figure 4: Effects of WMPF fibres on VeBe times values of concrete containing 0% RHA and 15% RHA.

3.2. Compressive Strength

The result of cube compressive strength of all the concrete mixtures gotten from the laboratory test shows a trend of reduction as the fibre volume fraction is increased. Figure 5&6 reveals the experimental results for the compressive strength of Portland Cement (PC) (0% RHA) and RHA-based concrete mixes (15% RHA) incorporating WMPF fibres at different curing periods. Relating the 28 days compressive strength values of the plain concrete mixture (0% RHA/% fibre), the inclusion of WMPF fibres at volume fraction of 0.25%, 0.5%, 0.75%, and 1% reduced the cube compressive strength by 5.75%, 9.43%, 12.25% and 18.65%, respectively. In concrete mixtures with 15% RHA, further reductions in compressive strength of 35.45% at 7 days and 11.68% at 28 days hydration were observed related to that of the PC based concrete mixture.

The acquired results of this study agree with those findings by Hossein *et al* (2018), who reported the decrease in compressive strength values by the adding of metalized plastic waste fibres. Air voids noticed in the matrix which consequently increased as fibres were further

added to concrete, and lead to the reduction in the compressive strength of the concrete. Hence, effects of air voids in reduction of strength was more real, compared to arresting the further crack openings. Beyond 28 days, the compressive strengths of RHA-based concretes tended to increase with the curing age for all fibre volume fractions and gave higher compressive strength than that of Portland Cement (PC) concrete at 56 days. This can be described by the fact that the higher fineness of RHA develops pozzolanic properties and particle packing density. These characteristics tend to develop concrete strength as well as its density (Chandara, *et al.*, 2010; Safiuddin *et al.*, 2011; Megat *et al.*, 2012). Figure 7 presents the failure mode comparing the Plain concrete and fibre reinforced concrete. The plain concrete without the fibre was observed to exhibit a catastrophical failure under load while the Fibre reinforce concrete displayed a ductile mode of failure when exposed to a static loading system.

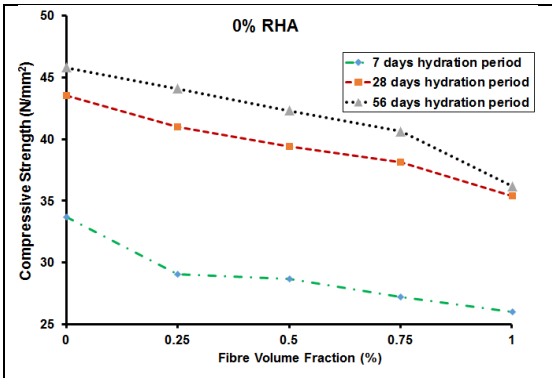


Figure 5: Upshot of WMPF fibre Content on Compressive Strength of Concrete Containing 0% RHA at vaying hydration period

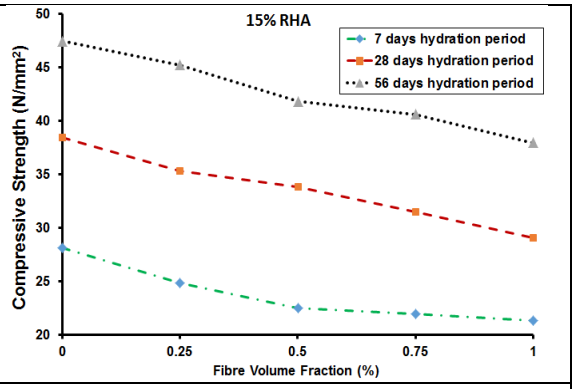


Figure 6: Upshot of WMPF fibre Content on Compressive Strength of Concrete Containing 15% RHA at vaying hydration period

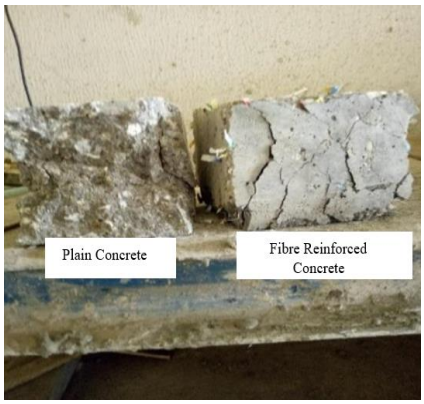


Figure 7: Comparison of failure modes of concrete specimens with (fibre reinforced concrete) and without WMPF fibre (plain concrete) after subjected to compressive load

3.3. Splitting Tensile Strength

The variant in the results of tensile strength against WMPF fibre volume fractions is shown in Figure 8 and 9. The inclusion of WMPF fibres and increased in the fibre content produced a tensile strength values of concrete mixtures that is noticeably higher than those of the control mix (0% RHA/0% Fibre content). When the splitting occurred and was sustained, the WMPF fibres bridging the split portions of the specimens acted over the stress transfer from the matrix

to the fibres and then gradually supported the full tensile stress. The resistance against the indirect tension improved the strain capability of the specimens and therefore, results in higher splitting tensile strength of those specimens reinforced with short fibres than those of plain concrete mixture (Hsie *et al*., 2008). The integration of WMPF fibres and RHA contributed to the enhancement of tensile strength. At the age of 56 days, the splitting tensile strength of PC-based concrete mixes increased by 31.10%, 40.13%, 37.12%, and 33.11% for the fibre dosages of 0.25%, 0.5%, 0.75%, and 1%, respectively, associated to that of control concrete mix (0% RHA/0% Fibre content). Whereas, at the same curing period (56 days), the inclusion of RHA to the fibrous concrete, for instance, enhanced the strength values by 34.78%, 44.48%, 43.14%, and 39.13% for the similar fibres content, compared to the control mixture (0% RHA/0% Fibre content). The improvement in the tensile strength could be due to the greater contact surface area amongst WMPF fibres and the binder paste causing from the pozzolanic hydration process, which is in line owing to the good pozzolanic nature of RHA at the ultimate ages (Alsubari et al., 2016). A similar explanation on the enhancement in tensile strength of concrete by the addition of metalized plastic waste fibres has been reported in literature by Bhogayata and Arora (2017).

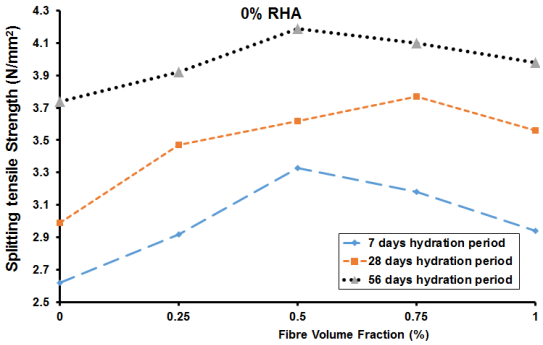


Figure 8: Effect of WMPF fibre Content on Splitting Tensile Strength of Concrete Containing 0% RHA

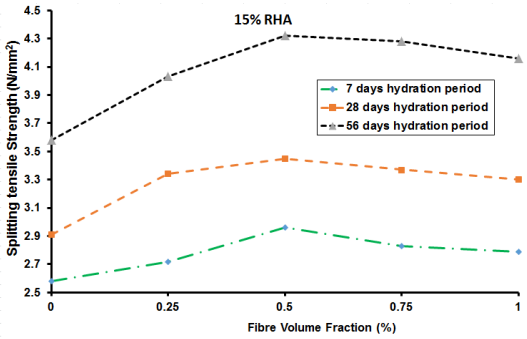


Figure 9: Effect of WMPF Content on Splitting Tensile Strength of Concrete Containing 15% RHA

5. CONCLUSION

This paper probed the effect of the inclusion of WMPF fibre and RHA on the workability, compressive strength and tensile strength properties of concrete composites. Based on the observations made and experimental results, the ensuing conclusion was made. The inclusion of WMP fibres in concrete mixtures affects the workability of fresh concrete mixes. The higher the WMPF fibre content, the lower the slump values and the higher the VeBe times becomes. The compressive strength of the fibre reinforced concrete mixtures reduces as the volume fraction of the fibre is increased. At early ages, the improvement in the compressive strength of mixtures containing RHA is observed to be similar to that of PC concrete mixes. At 56 days of hydration in water, the compressive strength of RHA-based concrete mixtures exceeds the values of PC concrete mixtures. In spite of the reduction in compressive strength, noteworthy developments in tensile strength of concrete composites was observed. The RHA-based concrete mixes reinforced with WMPF fibres attained a superior enhancement in tensile strengths owing to firm fibre-cement matrix boundary and densification of the matrix through the pozzolanic action of RHA. At the curing period of 56 days, the tensile strength increased by 40.13% for the PC-based concrete mixture and 44.48% for the RHA-based concrete

mixtures having 0.5% fibre as compared to the plain concrete mixture without any fibres. The development and mass production of green and sustainable concrete composites integrating RHA and WMPF fibres is feasible. Its performance as be demonstrated and is recommendable in the construction of low-cost housing, concrete road pavement sustainable infrastructures, bridge decks, , and other associated applications.

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Evaluation of Shear Bond Strength of Geopolymer Mortar Containing Cassava Peel Ash and Metakaolin

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Abstract

The cement industry has been recorded to have contributed immensely to the high global carbon dioxide emissions the word is contesting with today. This has made researchers to looked for other sustainable substitutes. One of the possibility substitutes is geopolymer mortar, which has no cement content in it. Geopolymer mortar can be produced using agricultural and industrial wastes like cassava peel ash (CPA), rice husk ash (RHA), metakaolin (MK), fly ash (FA), and many more. Geopolymer have been proven recently to be the way of converting agricultural, thermal and industrial waste into construction repair materials. When comparing Ordinary Portland Cement (OPC) mortar with geopolymer mortar, geopolymer mortar is considered as a highly eco-friendly product. This paper evaluates the compressive and shear bond strength properties of geopolymer mortar manufactured using Cassava Peel Ash (CPA) and Metakaolin (MK). Sodium silicate (Na_2SiO_3) and 9 molar concentration of sodium hydroxide (NaOH) solution were used as alkaline activator. The mass ratios of sodium silicate to sodium hydroxide (NS: NH) and the binder to fine aggregate (B: A) were fixed to 2.5 and 0.4 respectively. The compressive strength of the synthesized GPM were determined at 3, 7 and 28-days. The compressive strength at 28 days curing was 46.5 N/mm^2. Results revealed that 50% replacement of MK with CPA made with 9M concentration of NaoH enhanced the compressive strength of the mortar while 100% CPA content in the mortar demonstrated the highest shear bond strength value. The grooved surface improved the bonding strength. The bond strength results have proven that the surface texture must be considered in determining the bond strength. It is concluded that geopolymer mortar incorporating 100 percent metakaolin could be used in the construction industry with the almost negligible amount of environmental problems.

Keywords*: Geopolymer; Binder; Metakaolin; Cassava Peel Ash; compressive strength; bond strength.*

INTRODUCTION

The cause for deterioration of the concrete structure located in severe environment has been explored both in field and in laboratory. Serious cracking and spalling appeared upon surface of the concrete structure soon after the structure was put into service (Zhao *et al.*, 2018). In order to maintain and increase the service life of the structures against the destructive agents, it is necessary to prevent major damages through proper concrete repairs (Mohammadi *et al.*, 2014. Several repair materials are developed for concrete structures including cement-based materials, polymers, latex, etc (Chung, 2018). Geopolymers find wide range of applications in the areas of surface membrane materials, surface repairs, Nuclear waste disposal, coating and transportation (Mirza *et al.*, 2014; Van Deventer *et al.*, 2007; Zang *et al* 2014; Balaguru 1998; Zhang *et al* 2010). New applications including the use of Geopolymer as concrete repair material is under in-depth exploration. In recent times, use of the alkali activated mortar as surface concrete repair materials has generated renewed research interests (Balaguru 1998; Zhang *et al.*, 2012; Zhang *et al.*, 2010b). The formation of GP was based on the reaction between the two parts of materials such as the alkali activator and the reactive aluminosilicate precursor (mainly MK). The GP based on alkali activation of MK became attractive not only because of its excellent thermal stability (better than conventional polymer material) but also due to its comparable mechanical properties to cement. Presently, GPMs are considered as a green alternative to Portland cement (Huseien *et al.*, 2018). Geopolymers commonly use alumino-silicate based (i.e., pozzolanic) industrial by-products (IBPs) (Bye, 2011), which are able to produce high compressive strengths, low shrinkage levels, acid and fire resistance and low thermal conductivity Duxson *et al.*, (2007; Weil *et al.*, (2009) conducted a sustainability comparison study between CEM-I and Australian geopolymers, which revealed that

geopolymers reduced greenhouse gas emissions by 44–64% (McLellan *et al.*, 2011). Metakaolin is an amorphous aluminosilicate that is highly reactive natural pozzolan produced by the calcination and dehydroxilation of kaolinite clay at temperature between 500°C and 900°C (Daman k.2019). Studies have been carried out to investigating compressive strength of Metakaolin base geopolymer mortar with other aluminosolicate based source materials. Effect of Metakaolin replaced granulated blast furnance slag on fresh and early strength properties of geopolymer mortar (Huseien *et al.*, 2016). The use of MK (together with other Al- and Si-bearing minerals) as raw materials appears more prospective and practicable (Zhag *et al.*, 2016). Influence of silica fume and metakaolin with two different types of interfacial adhesives on the bond strength of repaired concrete was studied by (Mohammadi *et al.*, 2014). Geopolymer exhibited higher bonding strength than that of comparable Portland cement mixture. the effect of molarity of sodium hydroxide, sodium silicate content and calcium to silicate ratio on shear bond of geopolymer mortar as repair material. They found that geopolymeric binders possess very high bond strength even at an early age as compared to commercial repair products. (Phoo-ngernkham, *et al.*, 2015). Considering the hazard of environmental pollution, and interesting attribute of MK, the objective of this study is to characterize the physical and chemical properties of CPA and MK constituents to develop a mixture proportion of binary blended alkali activated mortar. Determine the fresh properties of synthesized binary blend Geopolymer mortar. Investigate the compressive and shear bond properties of binary blend a Geopolymer mortar.

MATERIALS AND METHODS

Metakaolin

Kaolin powder was purchased from Alkanari, Gombe State, Nigeria It was calcined at 750°C for 4h. MK have a distinctive off-white colour close to that of the parent kaolin. the appearance of kaolin has an irregular pellet shaped particle with disordered arrangement changed from pure white to floral whitish after dehydrocyclization process. The EDS and XRD pattern of MK (Figure 1) demonstrate outstanding crystalline phase material with obvious detectable quantities of kaolinite and silica. The SEM image revealed (Figure 2). The chemical compositions of MK were determined using X-ray Fluorescence Spectroscopy (XRF). The XRF results revealed that the major constituents of MK are silicon oxide (SiO_2) and alumina oxide (Al_2O_3). Other components include ferric oxide (Fe_2O_3), calcium oxide, magnesium oxide, potassium oxide, etc. The typical chemical composition of MK is depicted in Table 1.

Cassava peel ash

Cassava peel ash gotten from Doko village in Lavun LGA of Niger state were used as raw materials (Binder). CPA possesses both cementitious and pozzolanic properties. CPA was gotten from dried Cassava peel was calcined at 500°C for 2hours and it is Dark Ash in colour. The EDS and XRD pattern of CPA showed an amorphous broad hump with peaks around 2θ= 27-56° confirming the high vitreous content of the sample (Figure 3). Sharp crystalline diffraction peak indicates it dominant amorphous phase and crystalline phases of 111,220,330. The SEM image shows gelatinous, irregular globular shape (Figure 4). Table 1 summarizes the chemical composition of CPA.

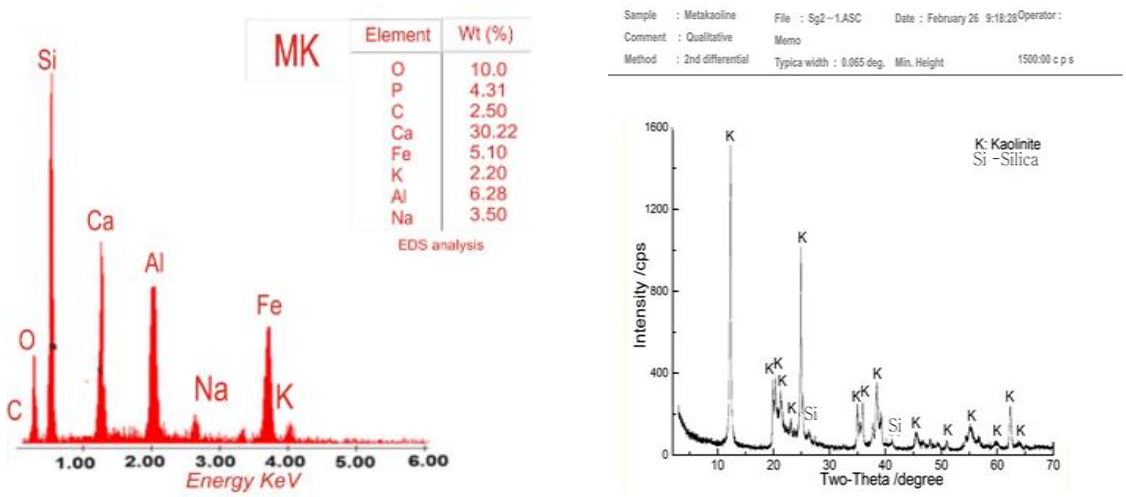


Figure 1: EDS and XRD patterns of MK

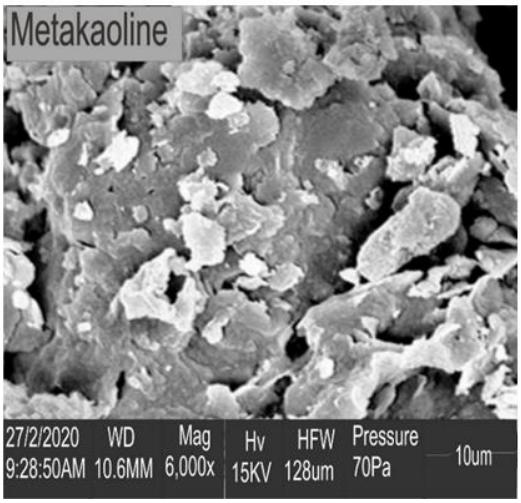


Figure 2: SEM image of MK

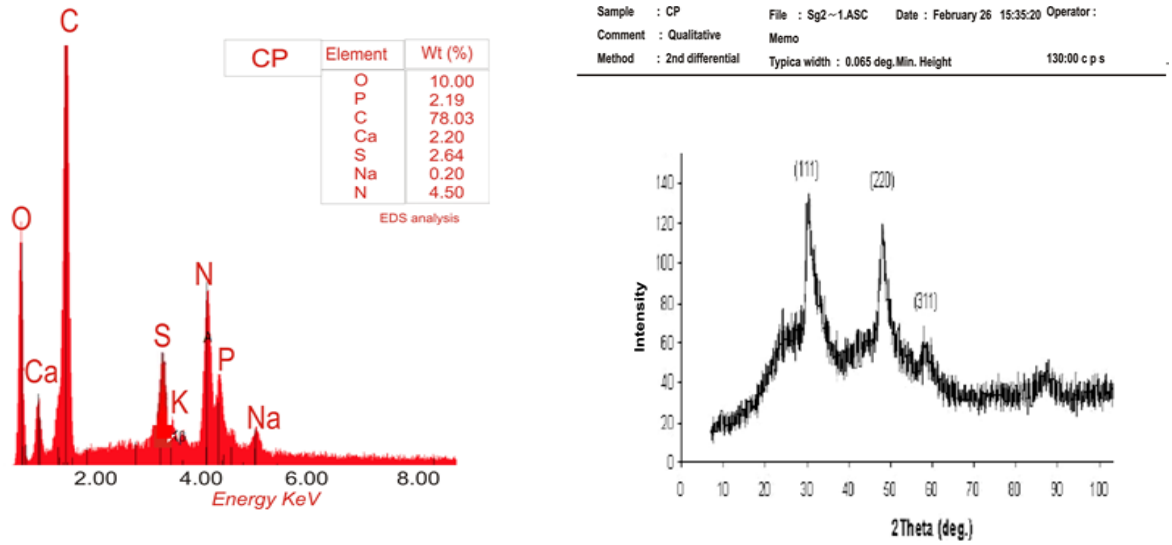


Figure 3: EDS and XRD patterns of CPA

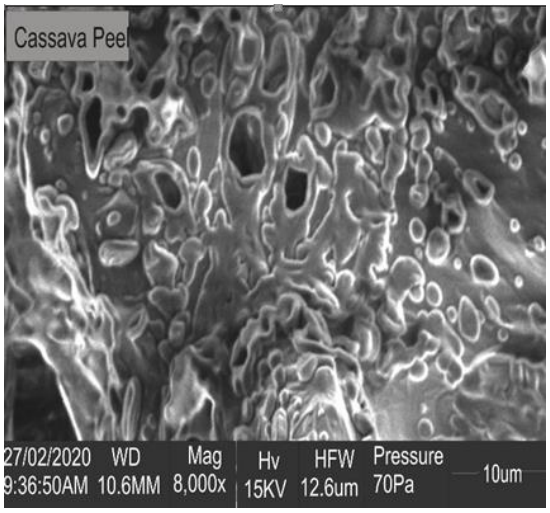


Figure 4: SEM image of CPA

Table 1: Chemical compositions of CPA and MK (Mass%)

Materials	SiO_2	Al_2O_3	CaO	SO_3	Fe_2O_3	Na_2O	K_2O	TiO_2	MnO	MgO	LOI
MK	72.39	20.35	0.01	-	1.12	0.34	3.12	0.90	0.02	0.12	2.35
CPA	80.83	0.77	4.24	0.83	1.55	0.06	5.50	-	0.05	-	

Alkali solution

A mixture of sodium silicate (NS) and sodium hydroxide (NH, purity 98%) alkaline solution used in the present study. These were used to activate the alumina and silica in MK and CPA. The NS solution was composed of SiO_2 (27.0 mass%), Na_2O (14.0 mass%) and H_2O (51.0 mass%) (Table 2). These chemicals were purchased from Niger State. A different amount of pellet was dissolved in water to prepare NH solution of 6, 9 and 12 molar concentrations. The solution was left for 24h to be cool, then it was added to a NS solution to prepare the final alkaline solution. The ratio of sodium silicate to sodium hydroxide (NS:NH) was 1:2.5 fixed for all mixtures of alkaline solution.

Table 2: Compositions of alkaline solution.

Alkaline Solution	NaOH solution (NH)			Na_2SiO_3 solution (NS)			NS:NH (mass%)
	Molarity M	Na_2O (mass%)	H_2O (mass%)	SiO_2 (mass%)	Na_2O (mass%)	H_2O (mass%)	
S1	6	18.6	81.4	27.0	14.0	59.0	2.5
S2	9	27.9	72.1	27.0	14.0	59.0	2.5
S3	12	37.2	62.8	27.0	14.0	59.0	2.5

Fine aggregate

Siliceous River Sand was used to prepare all mortar specimens. Finess modulus of the aggregate and specific gravity were discerned to be 2.32 and 2.56 respectively.

Mortar mixture proportions, sample preparation and testing methods

The geopolymer mortar was prepared using water to solid ratio (w/s) of 0.27, 0.26 and 0.25. The water content is the total water in activator and additional water whilst the solid is the CPA and MK and solid part of the activator. The ratio of binder to sand was 1:2.5. The geopolymer mortar was prepared by mixing MK with CPA over a period of 4 min at dry condition to achieve a homogenous mixture with fine aggregates. Then, the acquired mixture was activated by adding the alkaline solution to obtain a thorough mixed mortar. The prepared fresh mortar mix was then cast into cubic moulds of size 50 mm x 50 mm x 50 mm and cylindrical moulds of

dimension 50 mm x 100 mm. The casting was performed in three layers, where each layer was compacted. The samples were left for 24 h after casting before subjected to oven curing at 100°C for 24 hours. In Addition, CEM 1 cement mortar with 0.5 w/c ratio and sand-cement ratio (S/C) of 2.5 was also cast as control for comparison. The mortar specimens were tested for 3, 7 and 28 days to evaluate the compressive strength and bond strength in accordance to ASTM 109 and other mechanical properties. Table 3 depicts the achieved three different phases of mixtures which are 100%/0% of CPA/MK, 50%/50% of CPA/MK and 0%/100% of CPA/MK. The optimum ratios from the previous three stages are selected to evaluate the bond strength of GPM. The results are compared with CEM 1 cement mortar as a control sample. The control sample was made of Portland cement, fine aggregates and water. Fine aggregate to cement ratio by mass of 3:1 was considered. The fine aggregate was kept in a saturated surface under dry condition. The water to cement (w:c) ratio was set at 0.5.

Table 3: Mix proportion of geopolymer

Phase	Binder mass%		Alkaline solution type	S: B mass%	B: A mass%	H_2O: binder mass%	NaOH molarity
	CPA	MK					
1	100	0	NHNS	0.50	1.3	0.4	6,9 &12
2	50	50	NHNS	0.50	1.3	0.4	6,9 &12
3	0	100	NHNS	0.50	1.3	0.4	6,9 &12

RESULTS AND DISCUSSION

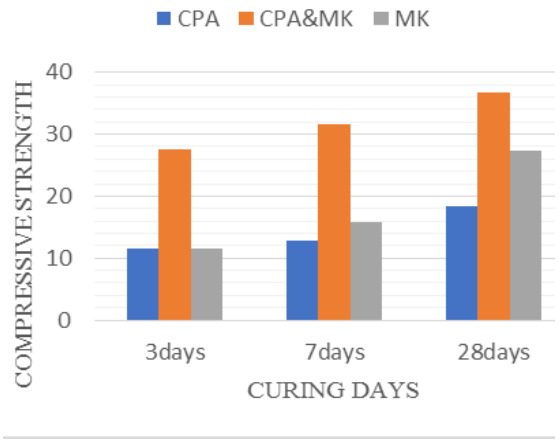
Compressive strength

Compression test on specimens was performed on 50 x 50 x 500 mm cubic samples. The average mortar compressive strength results of three repeated tests at ages of 3, 7 and 28 days are presented in Figures 5 (a,b &c), respectively. The test result of samples containing 100%/0% of CPA/MK, 50%/50% of CPA/MK and 0%/100% of CPA/MK with control specimen is presented in the Figure 5 (a,b &c).

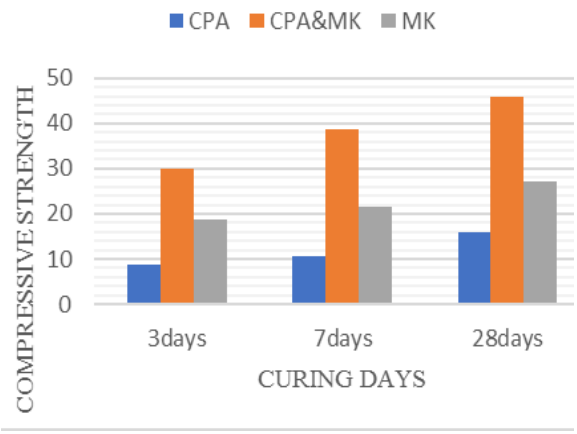
Bond strength

The shear bond strength capacity between the Portland cement substrate (NC) and GPM with stiffer slant shear angle 30° was evaluated. For casting of the specimens, the NC was casted and cured for 28 days in the water. Afterward, they are fixed in cylinder moulds (50mm x 100 mm), casted for the second part (CEM 1 and GPM) and then evaluated after 28 days. The shear bond strength was defined as the ratio of maximum load at failure and the bond area. The reported results of shear bond strength were considered as the average of three samples. The procedure of shear bond test was presented in Figure 6.

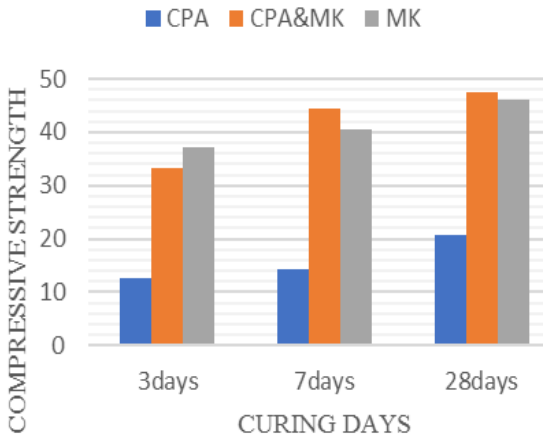
The bond strength between OPC (NC) and GPM was determined using a slant shear and half bond test. Cylinder slant shear specimens of dimension (50 mm x 100 mm) with interface line at 30^o (Figure 6) are prepared. The bond strength was tested at 28 days after curing at ambient temperature. The slant shear test is the most widely accepted test for the bonding of repair materials to concrete. The bond strength of GPM was determined on sample with 100% of MK, 50:50 of MK/CPA and 100% of CPA. Samples prepared with 100% MK having a grooved half share and smooth slant share displayed a bond strength of 1.1 MPa and 0.07 MPa at age 28 days respectively (Figure 7). The cracks were passed through the NC substrate and GPM interface.



(a) 6 molar concentration of NaoH



(b) 9 molar concentration of NaoH

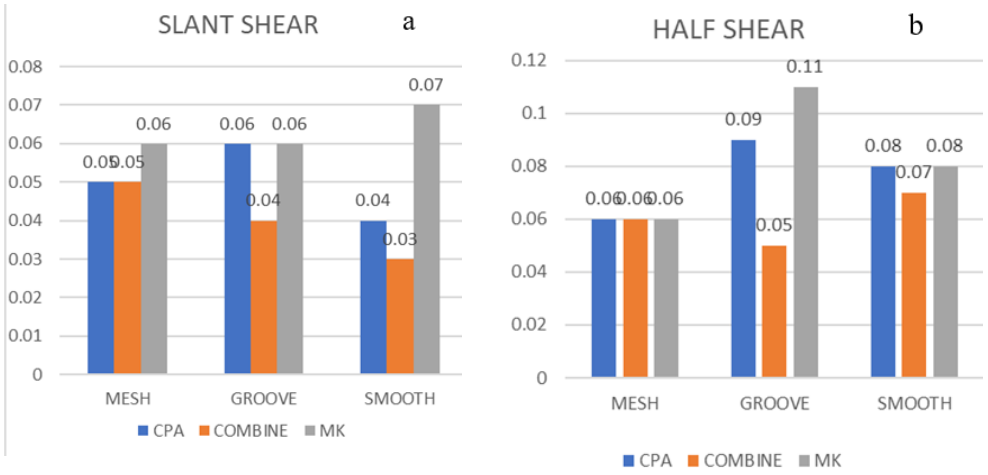


(c) 12 molar concentration of NaoH

Figure 5: Compressive strength of Geopolymer mortar at different Molar concentration

(a) GPM specimen (b) Slant shear bond test (c) Half shear bond test

Figure 6: Shear bond test displaying the failure mechanism



(a) Slant shear strength (b) Half shear strength

Figure 7: Effect of surface treatment on bond strength type

CONCLUSIONS

In this paper, the evaluation of the compressive and bond strength properties of Cassava peel ash (CPA) incorporated Metakaolin (MK) based geopolymer mortar was oven cured at 100oC for 24 hours and mainly based alumino-silicate precursors from Agricultural waste (CPA) and Metakaolin was discussed in this paper were studied. The main outcomes of this study are listed below:

- The strength of the prepared mortar was observed to be more as the materials combined than when used individually.
- A blend of Cassava peel Ash and metakaolin-based geopolymer mortar prepared with 9 molar concentration of NaoH showed the compression strength of 18.4 MPa at 28days curing.
- A blend of earth mining materials and Agricultural waste should be encouraged to produce cement free mortar and to enhance the strength and environmental amiability.
- Reviewing the results of the bond strength of the samples, the half share bond of the 100% MK with grooved surface showed a better bond strength while for shear slant bond, 100% MK with smooth surface gave a better bond.
- Generally, the developed formulations seem suitable as alternatives to traditional cementitious mortars.

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Determination of the Compressive Strength Properties of Alkali-activated Millet Husk Ash - Calcium Carbide Mortar

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Abstract
Alkali-activation of agro-industrial wastes as an alternative binder to Portland cement (PC) is receiving more consideration most notably in the developed nations due to issue of green-house gas (CO_2) emission from the production process of PC. This research focused on developing a suitable proportion combination of millet husk ash (MHA) – calcium carbide waste (CCW) and evaluate the fresh and hardened properties of alkali-activated MHA – CCW binder-based mortar sample. The chemical analysis of the supplementary cementitious materials via X-ray fluorescent (XRF) revealed MHA having 73.4% silica (SiO_2) content, while CCW primarily contains CaO (66.1%). Three combination proportions of MHA – CCW (40:60, 45:55 and 50:50) were activated with different molar concentrations of sodium hydroxide (NaOH): 5M, 10M, 15M and 20M respectively. The mortar was produced at 1:3 binder/sand (B/S) and 0.5 water/binder (W/B) examined for binding, hydration and strength development and water absorption at varied curing age (3, 7, 14, 28, and 56 days respectively) in accordance to BS EN 196-1: 2016. The MHA – CCW samples tested exhibit increasing performance for both properties examined with increasing NaOH concentration up to 15M but decreased performance at 20M for all combination proportions. At 56 days of curing the 45:55 MHA – CCW at 15M NaOH molarity possessing similar compressive strength and water absorption as the control.

Keywords: *Millet husk ash (MHA), Calcium carbide waste (CCW), Sodium hydroxide (NaOH), Alkali-activated binder, Compressive strength.*

INTRODUCTION
Cement is an important element in all types of construction for binder; and in recent years the cement market has been filled by one product, (Tsado *et al.*, 2014). In many countries, PC is expensive and this has severely limited the construction of affordable housing (Didel *et al.*, 2014). As a result, developing alternative binder to PC is an excellent option at much lower cost toward making a significant contribution in the provision of low-cost building materials leading to affordable shelters (Abdullahi *et al.*, 2013). Olawuyi *et al. (*2017) reported that PC based binder is one of the essential construction materials in the world produced through calcination of calcium carbonate ($CaCO_3$) to give calcium oxide and carbon dioxide (CO_2) emitted to the atmosphere as shown in equation (1.1).

$$CaCO_3 \xrightarrow{heat\ (>900\ C)} CaO + CO_2 \quad (1.1)$$

$$CO_2 + SiO_2, + Al_2O_3 + Fe_2O_3 \xrightarrow{heat\ (>1450\ ^oC)} CaO, SiO_2, Al_2O_3\ \&\ Fe_2O_3 \quad (1.2)$$

The basic components of a PC are calcium oxide (CaO), silica (SiO_2), alumina (Al_2O_3) and ferric (Fe_2O_3) with strength determinant being the SiO_2 which combined with CaO in the presence of water to form hydrated lime – $Ca(OH)_2$. This reaction leads to the formation of calcium silicate hydrate – $CaO\text{-}SiO_2\text{-}H_2O$ (C – S – H), the end product of strength development in cement hydration process after water contact (Mehta & Monteiro, 2014). This article reports an attempt at alkali-activation of a pozzolan (as SiO_2 source) with a good CaO source as a complete replacement of PC towards proper binding and strength development properties in mortar and concrete.

Pozzolans are fine materials that contain silica and alumina which on their own have little or no binding property but when combined with lime in the presence of water, will set and hardened like cement (Abdulfatai *et al*., 2013). The utilization of pozzolanic materials, for example, sawdust ash (SDA), rice husk ash (RHA), metakaolin (MK), fly ash (FA), silica fume (SF) and natural pozzolans as partial cement clinker replacement will help to minimize CO_2 emissions known to accompany cement production, (Damtoft *et al*., 2008). Research trends on alternative binder had focused on the utilization of natural pozzolans i.e. volcanic ash (Hossain, 2003 & 2005; Hassan, 2006; Olawuyi, 2011; Hassan, 2016). Agricultural waste ashes such as RHA (Okpala, 1987; Chaowat, 2001; Abalaka and Okoli, 2013), SDA (Elinwa and Mahmood, 2002), corn-cob ash [CCA] (Raheem, 2010), millet husk ash [MHA] (Jimoh *et al.*, 2013) and palm kernel nut ash [PKNA] (Joshua *et al.*, 2015) amongst others having been used as a partial PC replacement in mortar or concrete. Olonade and Bello (2018) and Qureshi and Ghoshi (2013) on the other hand, worked on alkali-activated cocoa shell ash (CSA). According to Mehta and Monteiro (2014), pozzolanic reaction is the same pattern as that of PC using Tri-Calcium-Silicate (C_3S) with water (H) to give Calcium-Silicate-Hydrate (C-S-H) and Calcium Hydroxide (CH).

The (Portland- pozzolan) cement reactions are shown in equation (1.3) and (1.4) as follows:

$$C_3S + H \rightarrow C - S - H + CH \quad (1.3)$$

$$\text{Pozzolan} + CH + H \rightarrow C\text{-}S\text{-}H \quad (1.4)$$

Where C = CaO, S = SiO_2 and H = $(OH)^-$

The reaction in equation (1.3) is known to be fast and lime producing while the reaction in equation (1.4) is rather slow or latent depending on the properties of the pozzolanic material.

Alkali activation as defined by Martinez and Palomo (2001) is the chemical process where an amorphous structure is transformed into a skeletal structure that exhibits cementitious properties. The material containing reactive silica or alumina can be activated as shown in equation (1.5) and (1.6).

$$Na(OH)_2 + SiO_2 \rightarrow \text{N-S-H (Gel) as in geopolymer} \quad (1.5)$$

$$Na(OH)_2 + Al_3O_2 \rightarrow \text{N-S-H (Gel) as in geopolymer} \quad (1.6)$$

Where N-S-H (Gel) is Sodium-Silicate-Hydrate Gel.

Bakharev (2006) reported that concrete produced using alkali-activated fly ash with NaOH achieved a two-day compressive strength of 10 N/mm^2 while the 28days compressive strength was 60 N/mm^2. Bakharev (2006) also reported two days compressive strength of 2N/mm^2 and a 28-day compressive strength of 45 N/mm^2 from fly ash activated with sodium silicate (Na_2SiO_2).

EXPERIMENTAL PROCEDURE

Materials

The materials used for the study are MHA, CCW, NaOH, CEM II 42.5N (Dangote 3X cement) and fine aggregate. The MHA was obtained from Garatu village near Minna) in Bosso Local Government Area of Niger State, Nigeria. The husk was burnt in an open-air with locally fabricated incinerator presented earlier in Abalaka (2013). This material was ground to finer particles at Central Services Laboratory of National Cereals Research Institute (NCRI), Badeggi, near Bida, Niger State and sieved with a 75 µm sieve and the particles passing used as the MHA –SiO_2 sources for the study. CCW– an industrial waste of acetylene gas production was collected from the disposal area of a local automobile Welder's ("Panel Beater's") workshop in the mechanic village of Keteren-Gwari, Minna, Niger State. It was sun-dried for a day and calcinated in a furnace at a temperature of 700^o C to obtain its amorphous form and

was used as the CaO source. The NaOH used was purchased from Panlac Chemical Laboratory, Minna.

Methods

The study involved determination of physical and chemical properties of the constituent materials, suitable proportion combination of MHA- CCW were assessed for strength development and water absorption properties of the alkali-activated binder-based mortar samples considered. PC based mortar samples of 1:3 (C/S) at 0.5 water/cement ratio (W/C) prescribed in BS EN 196-1:2016 served as control while for the alkali-activated binder based mortar, varied proportion combinations of MHA-CCW with different concentration of NaOH were prepared and tested for the strength development and water absorption at requisite curing ages of 3, 7, 14, 28 and 56 days. The test procedures are further discussed sections 2.2.4 and 2.2.5.

Determination of Physical Properties of Fine aggregate, MHA and CCW

Particle size distribution test was conducted on the natural sand using the dry-sieve approach in accordance with BS EN 933-1 (1997) for proper classification of the sand sample. The particles passing the 1.18mm sieve but retained on the 75µm sieve was used for the study. The 75µm sieve was used as the limit value for sand used as presented in Figure 1 in consonance with BS EN 196-1 (2016) reference sand prescription for strength test on cement. The specific gravity of all materials used in this study was determined following the provisions of BS EN 1097 (2013). Also, the fineness test on the various combinations of MHA–CCW with varied molarities of NaOH and PC (CEM II 42.5N) were determined using the method as specified by BS EN 196-6 (2016) using the 53µm sieve.

Particle size distribution (PSD) and BET specific surface area of supplementary cementitious materials (SCMs) used was conducted with the use of Malvern Zetasizer Instrument at the Centre for Genetic Engineering and Bio-informatics Technology, Federal University of Technology, Minna, Niger State.

Determination of Chemical Composition of Cement, MHA and CCW

X-ray fluorescence (XRF) analysis for the oxide composition was conducted on the cementitious materials (MHA, CCW and PC) at National Geoscience Research Laboratory, Kaduna State.

Determination of Mixing Proportion of MHA and CCW

The suitable mix proportions of MHA and CCW was determined adopting the molar ratio concept taking cognizance of the SiO_2 and CaO contents of MHA and CCW respectively to arrive at 40:60; 45:55; 50:50 of MHA-CCW combination proportions. For the control mortar mix, CEM II, 42.5N was used at 1:3 C/S at 0.5 W/C. NaOH at different concentrations of 5, 10, 15, 20M was prepared for the study. The choice of NaOH concentrations was based on the findings from the Olonade and Bello, (2018) and Ammar *et al.,* (2013).

Determination of Compressive Strength of Mortar Sample

The compressive strength is a key property of mortar to which numerous of its characteristic are related (Neville, 2012). 50 mm cube mortar samples were cast and cured by water immersion for the requisite ages (3, 7, 14, 28 and 56 days) before testing for compressive strength. The mortar cubes were removed from the curing tank and put in the open air in the laboratory to surface dry, weighed and placed at the centre of hydraulic Digital Universal Testing Machine (DUTM - 20) for crushing force (P) determination in consonance with BS EN 196-1 (2016). The compressive strength was calculated using equation (2.1).

$$CS = \frac{P}{A} \quad (2.1)$$

Where;
CS = compressive strength in N/mm^2; P = maximum load at failure in N (Newton) and A = cross-sectional area, in mm^2.

Determination of Water Absorption of Mortar Sample

The water absorption test involved removing the mortar cubes were removed from the curing tank and allowed to surface-dry before placed in the electric oven to the oven-dry at 105 ^oC for 72 hours. The oven was then switched off, allowed to cool back to room temperature before removing the test samples and weight measurements taken and recorded as initial weight (w_1). The final weights were determined after immersing the mortar samples in the curing medium for 30 minutes, removed, towel-dried, re-weighed again and the value was recorded as (w_2). The water absorption of the mortar samples was then calculated using equation (2.2) under BS 1881-122, (2011)

$$Water\ Absorption = \frac{(w1-W2)*100}{w1} \quad (2.2)$$

RESULTS AND DISCUSSION

Characterization of the constituent Materials

Summary of the sieve analysis on the natural sand as presented in Onuche et al. (2019) is shown in Table1 and revealed the sand to be well-graded and of fine classification (C_c = 2.5, C_u = 1.0 and FM = 2.3) in line with Shetty (2004) specification. MHA was also reported as meeting the quality criteria of even dispersal, giving an average particle size of 180.23 nm and BET specific surface area value of 360.5 m^2/g. The data quality of the CCW sample was, however, observed to be poor and poly-disperse for distribution analysis. The CCW sample has an average particle size of 109.01 nm and BET specific surface area of 414.245 m^2/g.

Table 1: Summary of Sieve Analysis of Natural Sand

D10	D30	D60	Cc	Cu	FM
0.22	0.34	0.55	2.50	0.96	2.30

Specific Gravity of Constituent Materials

The specific gravity value of the constituent materials is presented in Table 2. The results indicate that the values fit well with the previous report in (Neville, (2012).

Table 2: Specific Gravity of Constituent Materials (kg/m^3)

Cement	MHA	CCW	NaOH	Sand
3.14	2.20	2.09	1.65	2.62

Chemical composition properties of MHA and CCW

The oxides composition of different cementitious materials was conducted at National Geoscience Laboratory, Kaduna. The MHA is a class N Pozzolan since the aggregation of the main oxides (SiO_2 + Al_2O + Fe_2O_3) gives 88.1% which is above the 70% minimum limit stipulated in ASTMC 618 (2012) standard as presented in Table 3.

Also, SO_3 is below 4% and Loss on Ignition (LOI) is less than 10%. The CCW was observed to contain 66.1% CaO, a similar value to the CaO content (65.0%) of the PC and lower SiO_2 and Al_2O_3. The LOI of CCW is above the specified 10% maximum which shows that there might still be presence of impurities in the sample.

Table 3: *XRF Analysis for Oxide Composition of Cementitious Materials*

Samples	SiO_2	Al_2O_3	LOI	Fe_2O_3	MgO	CaO	K_2O	TiO	MnO	SrO	CuO	ZnO	BaO	SO_3	$SiO_2+Al_2O+Fe_2O_3$
MHA	72.4	14.2	2.0	1.5	1.0	6.4	0.2	0.0	0.5	0.0	0.0	0.2	0.1	0.1	88.1
CCW	5.5	1.8	28.2	0.3	0.1	66.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.2	7.6
PC	21.3	5.1	0.0	1.1	2.8	65.0	0.0	0.1	0.0	4.4	0.0	3.5	0.0	3.5	27.5

Density

The average density of the control and various combination proportions of activated MHA-CCW at 28 and 56 days respectively are presented in Figures 4a, 4b and 4c. The average density of alkali-activated MHA-CCW mortar samples and the control varies from 2099 kg/m^3 to 2182 kg/ m^3. It showed that the density increased as the curing age increases. Mortar samples with density above 2000 kg/ m^3 are considered as normal weight mortar/concrete according to ASTM C 140:2003. Thus, higher density recorded by mortar from these alkali-activated binders was at 15M (45:55 MHA-CCW) and thereby still falls under the normal weight mortar classification.

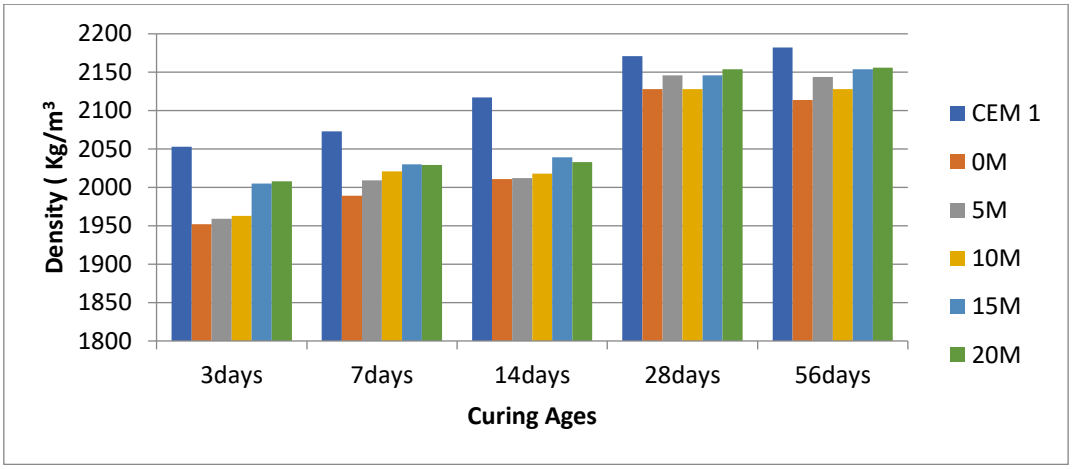

Figure 4a: Average density of 40:60 MHA/CCW mortar samples cured in water

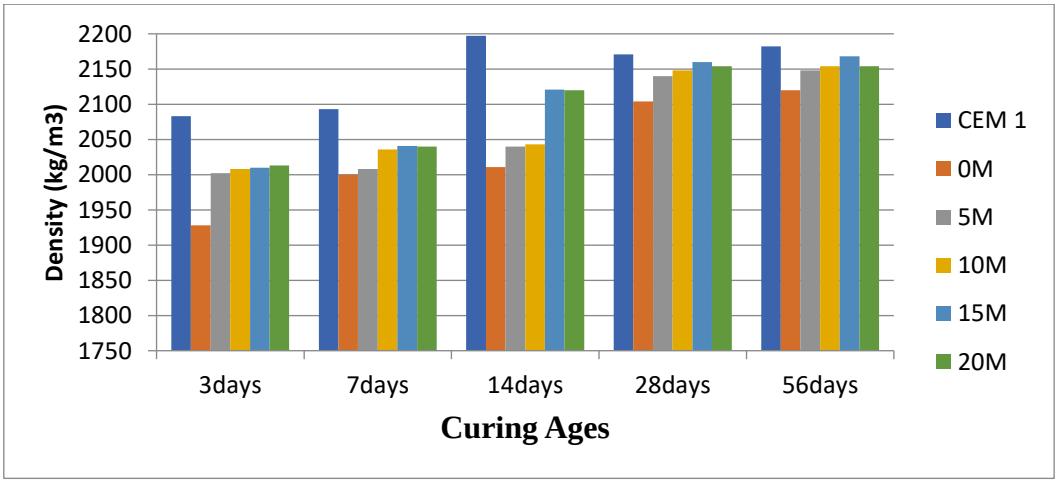

Figure 4b: Average density of 45:55 MHA/CCW mortar samples cured in water

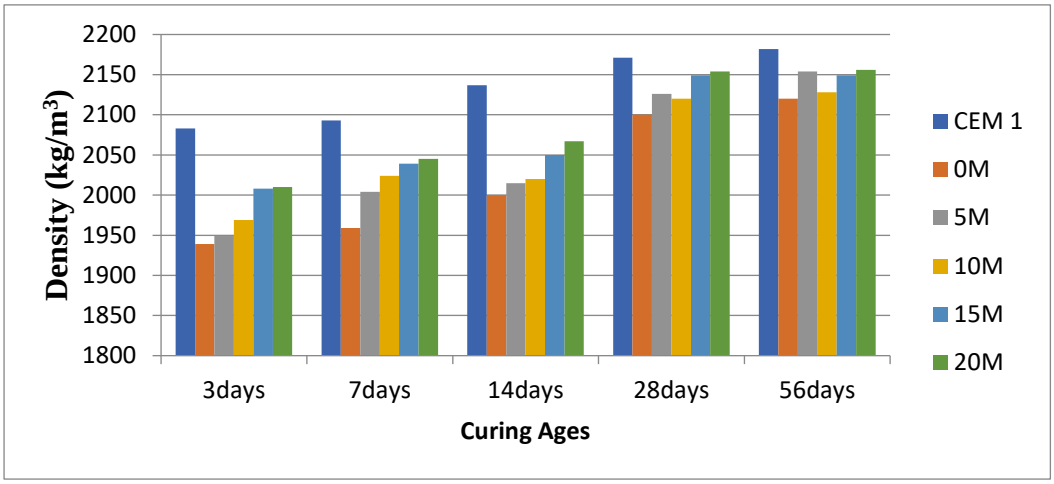

Figure 4c: Average density of 50/50 MHA/CCW mortar samples cured in water

Compressive strength of Alkali Activated MHA/CCW (AAMHA-CCW) Mortar Samples

The compressive strength of alkali-activated mortar at varied molar concentrations of NaOH solution is shown in Table 4. At the early age of 3 days, the 45:55 (MHA/CCW) activated with 15M of NaOH produced the highest strength of 6.92 N/mm^2 (i.e. 35% of its 28th-day strength – CS_{28}) which is higher than the stipulated minimum strength of 3N/mm^2 for load-bearing sandcrete blocks as postulated by the Nigeria Industrial Standard (2004).

Table 4: Compressive Strength of Alkali-Activated MHA-CCW Mortar

Specimens		NaOH (M)	Compressive Strength (N/mm^2)					CS_{28} Factor				
			3days	7days	14days	28days	56days	3days	7days	14days	28days	56days
PC		0	10.24	16.02	20.26	26.29	28.04	0.39	0.61	0.77	1.00	1.07
MHA/CCW	40/60	0	1.80	1.96	3.33	7.44	7.92	0.24	0.26	0.45	1.00	1.06
		5	2.68	3.38	5.35	9.76	11.48	0.27	0.35	0.55	1.00	1.18
		10	4.59	6.98	9.71	13.84	15.28	0.33	0.50	0.70	1.00	1.10
		15	6.52	9.00	15.33	18.45	22.66	0.35	0.49	0.83	1.00	1.23
		20	4.00	5.85	10.17	16.02	18.52	0.25	0.37	0.63	1.00	1.16
	45/55	0	1.96	2.08	3.84	7.68	8.20	0.26	0.27	0.50	1.00	1.07
		5	2.80	3.91	5.44	10.28	12.20	0.27	0.38	0.53	1.00	1.19
		10	4.77	7.78	10.19	14.69	16.44	0.32	0.53	0.69	1.00	1.12
		15	**6.92**	**10.72**	**15.96**	**19.77**	**24.52**	**0.35**	**0.54**	**0.81**	**1.00**	**1.24**
		20	4.72	6.12	10.56	16.45	20.64	0.29	0.37	0.64	1.00	1.25
	50/50	0	1.84	2.00	3.76	7.23	8.04	0.25	0.28	0.52	1.00	1.11
		5	2.72	3.87	5.41	10.00	11.56	0.50	0.27	0.39	0.54	1.00
		10	4.65	7.53	9.95	14.36	15.88	0.32	0.52	0.69	1.00	1.11
		15	6.80	9.95	15.48	19.32	23.24	0.35	0.52	0.80	1.00	1.20
		20	4.20	5.96	10.21	16.25	19.88	0.26	0.37	0.63	1.00	1.22

As the curing age of AAMHA-CCW increased, it was observed that the rate of strength development increased with increase in the concentration of NaOH from 5M to 15M but at 20M, slight decrease in strength was observed. This trend implies that the maximum strength recorded for AAMHA-CCW on the 56th day was at 45:55 proportion combination activated

with 15M of NaOH, the similar value was observed for the 50:50 samples at 15M NaOH. This result conforms to the findings by Ramujee and Potharaju (2014) which reported that the compressive strength of alkali-activated binder increases as the molar concentration of NaOH increased up to 15M. This concentration of NaOH resulted in good bonding between the aggregate and the mortar paste until the maximum concentration for activation is achieved.

The strength of the AAMHA-CCW mortar also increased as the curing ages increased for all the proportions combinations of MHA-CCW. The 7 and 14 days strength for 45:55 MHA-CCW activated with 15M NaOH were 10.72 N/mm^2 and 15.96 N/mm^2 i.e.67% and 79% respectively of the PC-based sample at the same age. The 28-days strength for the 45:55 MHA-CCW, 15M NaOH sample showed higher strength gain of 29% as against 23% strength gain of the PC-based mortar. Further curing of AAMHA-CCW mortar till 56days resulted in an additional 24% strength gain over the 28th day as compared to the 7% increase of the control. The trend is the same for all the AAMHA-CCW mortar studied up to 15M NaOH concentrations. This study considers the 15M NaOH activation of 45:55 MHA-CCW as the indicated proportion for good strength.

CONCLUSION AND RECOMMENDATIONS

In this study, agro-industrial waste materials (MHA and CCW) were activated at varied molarities of NaOH for performance assessment at utilization as an alternative binder in mortar as compared to PC based mortar. The chemical analysis reveals MHA as class N pozzolan of high SiO_2 content (72.4%) while CCW is good CaO source showing percentage concentration of 66.1% similar to the control. The PSD analysis and BET specific surface showed the MHA particles distribution to be of good quality and dispersed uniformly while the CCW particles are too poly-disperse for distribution analysis due to its fluorescence and sediment particle nature. The compressive strength results of AAMHA-CCW at 15M NaOH showed the best combination proportions and of similar characteristics as the PC based mortar. At 56 days of curing, AAMHA-CCW mortar cube samples revealed 15M of NaOH and 45:55 of MHA-CCW possessing compressive strength value near that of control.

Based on the finding of this study, the following are recommended:

i. Future studies on the product of hydration should be conducted using scanning electron microscopy (SEM) and X- ray diffraction (XRD) analyses.
ii. Influence of further heat treatment on the CCW sample and the effect on the performance of the alkali-activated binder should be investigated.
iii. There were potential that the AAMHA-CCW could be further explored using different optimization approach to produce higher strength for structural use, like normal strength mortar.

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Compressive Strength Characteristics of Mortar Containing Pulverised Volcanic Ash and Metakaolin as Cement Replacement

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Abstract:
Cement is one of the most important building materials used for construction worldwide. However, environmental concerns regarding rapid consumption of natural resources and CO2 emission during cement manufacturing process have brought pressure to reduce cement consumption by the use of cement supplementary materials. The utilization of calcined Metakaolin in concrete has received considerable attention in recent years. In this study, Pozzolanic materials of pulverised volcanic ash (PVA) and Metakaolin (MK) were investigated for use as supplementary cementitious materials in cement-based mortar, to serve as alternative to ordinary Portland cement (OPC). To achieve the objectives of this study, mortar of 0.30 and 0.40 w/c ratios were designed at 0%, 30%, 50%, 70% and 100% replacement by weight of OPC with a combination of 20:10, 30:20, 50:20 and 70:30 for PVA: MK mix proportions. Mortar specimens were cured in water, air and polythene for a total curing period of 3, 7, 14, 21, 28, and 56 days. Results obtained shows that the compressive strength of samples varied with the curing conditions to which they are subjected. Generally, sample cured under water exhibited superior performance in comparison to samples cured under air and polythene. Samples produced with 0.30 w/c ratio cured in water performed excellently well, with compressive strength values ranging between 6MPato 18.12 MPa for hydration period from 3-56 days. Samples cured under the polythene tend to perform closely, with compressive strength values ranging between 5.80MPato 16.16 MPa. The compressive strength at early days decreases as the percentage replacement increases. However, as the hydration continuous up to 56 days, the sample showed increase in strength. This was observed particularly with the replacement of OPC with 30% pozzolanic materials which was higher than that of the control. Hence 30% (20% PVA and 10%MK) combination is considered suitable for mortar production.

Keywords: Calcined, volcanic ash, Metakaolin, Air curing, Polythene curing Compressive Strength

INTRODUCTION

Cement is one of the most important building materials used for construction worldwide (Jayewardane, *et al*., 2012). However, environmental concerns regarding rapid consumption of natural resources and CO_2 emission during cement manufacturing process have brought pressure to reduce cement consumption by the use of cement supplementary materials (Neville, 2012).

Consensus of research opinions reported that the production of Portland Cement (PC) has been on the increase annually by 7%. Furthermore, it has been reported that the manufacturing process of PC usually contribute around 5% of global CO_2 emission resulting from clinker production and the fossil fuel used for pyro processing (Olutoge *et al.*, 2010; Nattapong *et al*., 2011; Rubenstein, 2012). In other to reduce this problem of CO2 emission which has been considered very harmful to the environment, a lot of researches are ongoing with a view to finding suitable alternatives PC (Khana *et al*., 2014).

Tennis (2002) and Basheer et al., (1999), believe that the development of supplementary cementitious materials (SCM) is fundamental to advancing low-cost construction materials to be used in the production of self-sufficient means of shelter, especially in developing countries.

Further interest in construction will revolve around the many merits and benefits associated with using SCMs, among which are improved properties of concrete, saving natural resources and energy as well as protecting the environment through the use of these admixtures. The most significant types of SCM are Pozzolan. Pozzolan are aluminosilicate materials which in the presences of water react with calcium hydroxide from Portland cement to form compounds possessing cementitious properties at room temperature that have the ability to set underwater (Krajči, *et al.*, 2013).

Interestingly, over some decades now, there has been increasing interests in the use of Metakaolin (MK) as a partial substitution of cement in concrete. Metakaolin (MK) is a supplementary cementing material that conforms to ASTM C618 − 12a (2013), Class N pozzolan specifications and it is considered as a pozzolanic material without direct cementitious value, but in the presence of moisture, reacts chemically with calcium hydroxide (CH) to form compounds possessing cementitious properties (Kadri, *et al*., 2011). The composition of MK is similar to clay, which is silica and alumina and produced from kaolin that was calcined at a temperatures of 800 ± 100 °C, which is much lower than that of cement (1450 °C); thus reducing CO2 emission and energy requirement (Khatib, *et al*., 2014).

Veiga and Velosa (2008), opined that Metakaolin is obtained from the calcinations of kaolinitic clays at temperatures in the range of 650^0C - 800^0C, high enough to allow for loss hydroxyls, but below temperatures that cause the formation of vitreous phase and crystallization of other phases such as mullite.

Shetty (2006) classified Metakaolin under the artificial pozzolans although it showed certain amount of pozzolanic properties, they are not highly reactive, but could be made highly reactive by subjecting it to water processing whereby uncreative impurities are removed.

Zhang and Malhotra (1995) reported that Metakaolin is a highly pozzolanic and "reactive" material which improves most mechanical and durability properties of concrete and mortar paste.

Gambhir (2004), described Metakaolin as a suitably processed aluminosilicate pozzolan which if well pulverized, reacts with slaked lime at ordinary temperature and in the presence of moisture to form a strong slow hardening paste.

Volcanic ash is formed when gases that are dissolved in molten rock expand rapidly from exposure to atmospheric temperature and pressure. As a result of this expansion, a violent explosion occurs that can break the molten rock apart. These fragments then cool down quickly and form glass. Fragments that are less than 2 mm in diameter are considered volcanic ash and can be composed of rock, minerals, and/or volcanic glass (ACI 232.1R-00 2001).

Shoji, et al., (2003) described that volcanic ash could be of various sizes, depending on the eruption style, and the smallest particle size (2mm in diameter) can travel hundreds to thousands of diameters downwind from a volcano. The distance it covers is dependent on the wind speed, volume of ash erupted, and height of eruption.

Volcanic ash (VA) has been used as a natural Pozzolan throughout history dating back to the ancient Greek and Roman civilizations (ACI 232.1R-00 2001). However, the availability of volcanic ash is dependent on volcanic activity and, more specifically, pyroclastic eruptions (eruptions that are accompanied with fast moving currents of hot gas and rock), the use of volcanic ash in concrete is less prevalent worldwide (Hossain and Lachemi, 2006). However, studies conducted on ash show that volcanic ash meets most requirements of ASTM C618 − 12a (2013) for natural pozzolans and contributes to the pozzolanic reaction in cementitious systems (Hossain 2005; Hassan, 2006; Olawuyi, 2011). Notwithstanding, VA has been reported to be slow in enhancing strength characteristics of the bulk paste matrix in mortar and

concrete (Hossain, 2006), hence the need to boost the reactivity index of VA by blending it with a more reactive Pozzolan like MK.
Calcined volcanic ash and Metakaolin are known to be pozzolans which exhibit cementitious properties. Thus, this research work is aimed at assessing the strength characteristics of calcined volcanic ash and Metakaolin in the production of mortar.

2.0 EXPERIMENTAL PROGRAM

2.1. Materials

The materials used in this research work are calcined volcanic ash, Metakaolin, ordinary Portland cement, fine aggregate (sharp sand) and water.
The Pulverised Volcanic Ash (PVA) was obtained from Mangu Local Government area of Plateau State. Since the ash is naturally calcined, no further heat treatment was necessary. It was then pulverized into powder form by first crushing using jaw crusher and further ground using mechanical grinding machine, after which it was sieved with 75µm sieve. The PVA has a combined oxide content ($SiO_2 + Al_2O_3 + Fe_2O_3$) equal to 73.13% and a specific gravity of 2.86.

The raw Kkaolin clay was obtained from Bida along Minna, - Lambata road of Niger State. It was then heated at a temperature range of 800 ^{0}C for 2 hours in the furnace to produced Metakaolin (MK). The MK has a combined oxide content ($SiO_2 + Al_2O_3 + Fe_2O_3$) equal to 89.75% and a specific gravity of 2.59.

Ordinary Portland Cement of CEM 1 I with 42.5 MPa strength and specific gravity of 3.15 was used in producing the mortar mixtures. The cement used was bought from a commercial store. The sharp sand used was a river sand commercially purchased from vendor with a specific gravity value of 2.6 and a fines modulus of 2.72.

2.2. Mix proportion of mortar, casting and testing

The mix proportion of mortar for masonry specified by BS EN 998-2 (2003) was adopted for mixing, casting and testing the specimens. The mixing was done using manual (hand mixing). The mixtures were proportioned for a target mortar cube strength of 10 N/mm2 + 5 N/mm2 for variation to have mean average strength of 15 N/mm2 at 28 days.

Specimens of 30 cubes of 50 mm x 50 mm x 50 mm were casted. The summary of the different mixture proportion is presented in Table 1. Normal mix proportion of 1:3 for mortar was applied for all the mix composition. Mortar mix of 0.30 and 0.40 w/c ratios were designed at 0%, 30%, 50%, 70% and 100% replacement by weight of OPC with a combination of 20:10, 30:20, 50:20 and 70:30 for PVA:MK mix proportions. The materials were weighed and mixed thoroughly until there was a uniform colour obtained to mortar paste. The mortar paste was then filled into the prepared mould, in three layers. The samples were left undisturbed and kept for 24 hours.

Sample specimens were cured in water, air and polythene bag for the period of 3, 7, 14, 21, 28, and 56 days. Then the compressive strength of the mortar samples was determined in accordance with the BS EN 196-1:2016 standard procedure for mortar cubes.

Table1: Mix proportioning of materials

Percentage Replacement (%)	percentage composition (OPC,PVA,MK)	Weight of OPC (kg)	Weight of PVA (kg)	Weight of Metakaolin (kg)	Weight of sand (kg)
0	100,0,0	2.0	-	-	6
30	30,50,20	0.6	1.0	0.4	6
50	50,30,20	1.0	0.6	0.4	6
70	70,20,10	1.4	0.4	0.2	6
100	0,70,30	-	1.4	0.6	6

3.1 Results and discussion

The test results of physical properties of the materials, chemical composition of the binders and compressive strength were analysed.

3.1.1 Physical properties of the materials

Figure 1 shows the particle size distribution of the sand. The particle size distribution indicated that the fine aggregate fall to medium grade quality of BS EN 13139 (2013) standard. The fineness modulus of fine aggregate was found to be 2.72, which is finely graded conforming to BS EN 13139 (2013) as stipulated and it was within the range of 2.3 - 3.0 of the standard. The Physical test results as presented in Table 2 shows that the sand has a specific gravity of 2.6 and the results of bulk density of compacted and un-compacted (loose) were determined to be 1600.00 kg/m^3 and 1500.00 kg/m^3, respectively. The ratio of un-compacted to compacted bulk density of fine aggregate was 0.94, which complied the ranged between 0.87 - 0.96 of BS EN 13139 standard. The specific gravity of OPC, PVA and Metakaolin are 3.20, 2.86 and 2.59 respectively

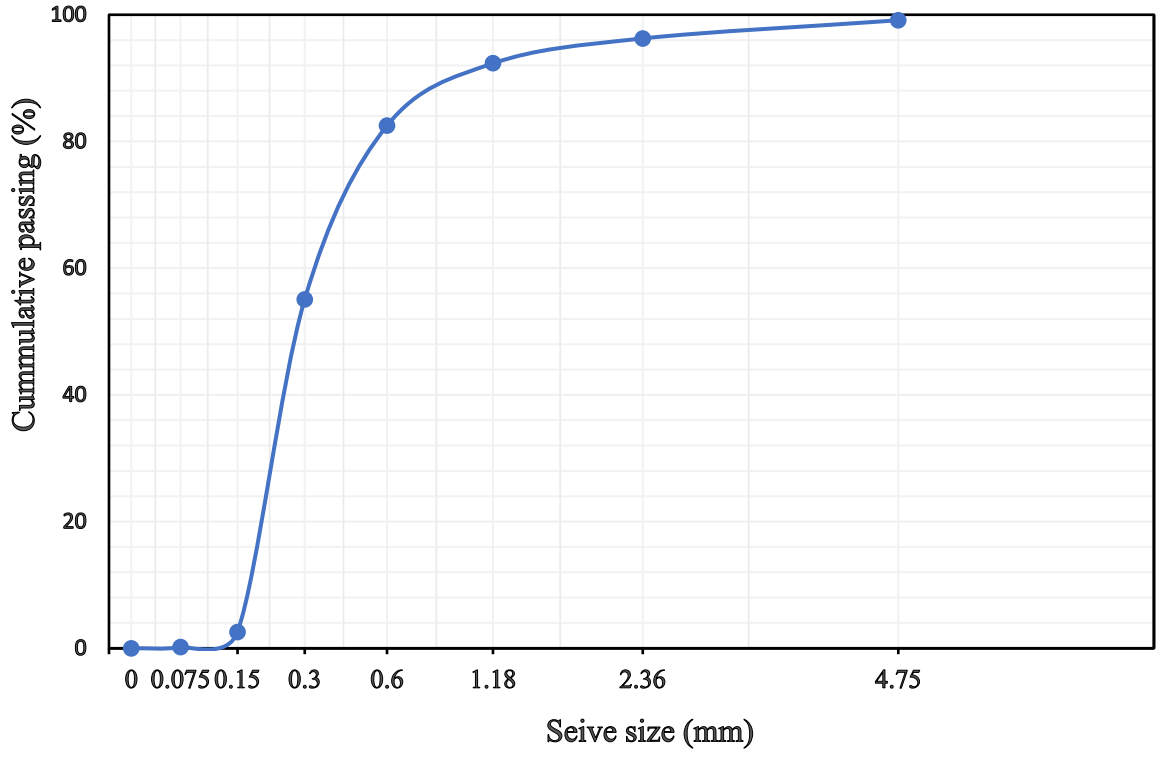

Figure 1: Particle size distribution for fine aggregate (sharp sand)

Table 2: Physical Properties of Constituent Materials

Property	Materials			
	Fine Aggregate	**OPC**	**PVA**	**MK**
Fineness Modulus	2.72	Not Applicable	Not Applicable	Not Applicable
Specific Gravity	2.6	3.2	2.86	2.59
Compacted Bulk Density	1600kg/m^3			
Un-compacted Bulk Density	1500kg/m^3			

3.1.2 Chemical composition of the binders

The chemical composition of calcined volcanic ash (PVA) and Metakaolin used for this study were presented in Table 2. The results illustrated that the combined percentage oxide of Al_2O_3, Fe_2O_3 and SiO_2 for PVA and Metakaolin are 73.13% and 89.75%, respectively. These values satisfied the minimum of 70% ASTM C618 − 12a (2013) standard requirements for pozzolanic materials. The silicon dioxide of PVA and Metakaolin also satisfied the 25% requirement of BS EN 197 (2000) standard for Pozzolan and the CaO is within the 10% ASTM C618 – 12a (2013) standard requirement.

Table 2: Chemical composition of (PVA and Metakaolin)

Chemical composition	% Concentration of PVA	% Concentration of Metakaolin
SiO_2	42.41	55.14
Al_2O_3	18.87	28.45
Fe_2O_3	11.85	6.16
CaO	6.82	2.01
MgO	4.49	0.84
Ka_2O	1.13	0.04
Na_2O	1.36	0.10
LOI	2.71	6.05

3.1.3 Compressive strength

Figures 2, 3, 4 and 5 present the average compressive strength values of the mortar samples at each different curing ages. The results obtained show that the compressive strength of the sample increases by an increase in the hydration age (3days to 56days) of the mortar sample and recorded with a compressive strength ranging between 5.80 to 16.16 MPa, 6.0 to 18.12 MPa for both polythene and water curing for the mix combination of 20% and 10% of PVA and MK, respectively.

There is an indication that the compressive strength obtained for the mortar samples depends on the percentage replacement of ordinary Portland cement. The results showed similar pattern of strength development across the hydration periods of 3, 7, 14. 28 and 56 days respectively. These results are 16.81 MPa for 100% OPC, while 18. 12 MPa, 12.40 MPa, 8.60 MPa, and 5.60 MPa for mortar specimens cured in water, while 14.29 MPa for 100% OPC, while 16. 69 MPa, 11.69 MPa, 8.17 MPa, and 3.87 MPa for specimens cured in polythene for proportion combination of 20:10%, 30:20%, 50:20% and 70:30% mixture of PVA:MK, respectively at 56 days. This shows that the compressive strength decreases, as the percentage replacement increases.

Another contributing factor for the compressive strength development of the mortar samples could be attributed to the condition under which they were produced. Samples produced with water-cement ratio of 0.3 shows higher compressive strength of 18.12. MPa compared with 15.91 MPa for 0.4 w/c ratio with the percentage composition mixture of 20% and 10% for PVA and MK respectively at 56 days for specimens cured water. This shows that when the water-cement ratio required for mixing Pozzolan is lowered, the performance strength of the material

increases. Similar observation was reported by Zhang and Malhotra (1995), in which case it was observed that Metakaolin requires little water content for its effective performance, since kaolin material on its own is highly water retentive.

Furthermore, It was also discovered that mortar samples cured in water showed superior strength development, this is closely followed by samples cured under polythene which tend to also give higher strength with increasing curing age of the samples than those cured in air especially at 20%:10% mixture of PVA and MK. The mortar results of 0.3 w/c and 0.4 w/c ratio at 56 days gives higher compressive strength of 18.12 and 15.91 MPa respectively for samples cured in water, 16.16 MPa and 13.88 MPa, respectively cured with polythene bag compared with compressive strength of 16.09 MPa and 13.75 MPa for 0.3 w/c and 0.4 w/c ratio, respectively for air curing.

Generally, it was deduced that pulverised volcanic ash at 20% replacement mixed with Metakaolin at 10% replacement, developed higher strength at 56 days. This indicates that the higher the curing age the more the strength development. This is largely attributed to the fact that pozzolanic reaction become pronounced after 28 days hydration period. At this point, the lime produced by the hydraulic reaction of Portland cement with water is consumed, thereby producing Calcium-Silicate-hydrate (C-S-H) with double bond which tend to densify the microstructure of the bulk paste matrix (Mehta and Monteiro, 2014)

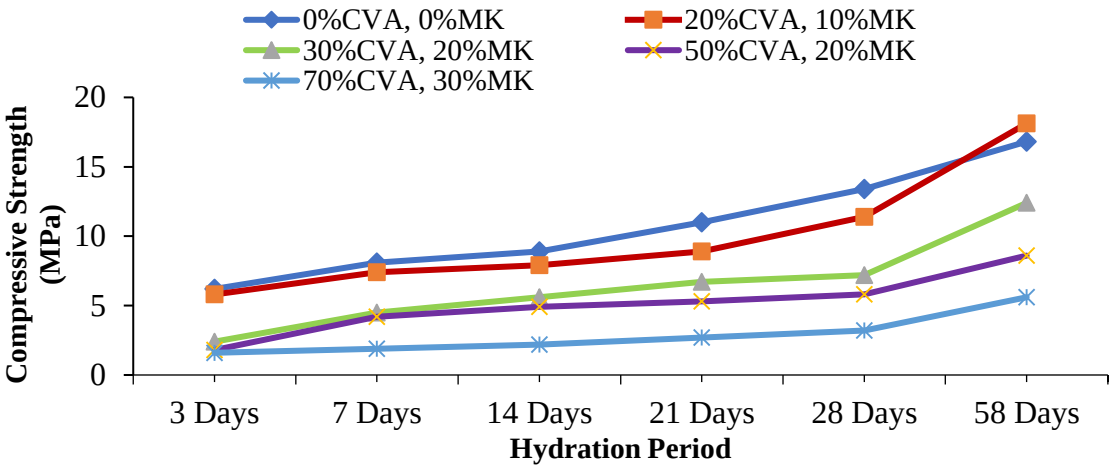

Figure 2: Compressive strength of 0.3 w/c mortar cured in water

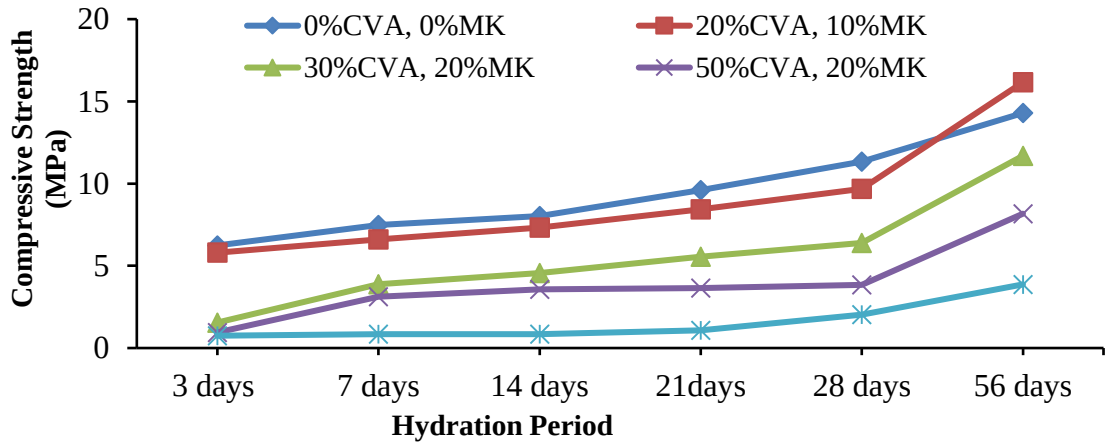

Figure 3: Compressive strength of 0.3 w/c mortar samples cured in polythene bag

Results also shows that both puverised volcanic ash and Metakaolin can be used in producing high performance mortar irrespective of the climatic factor or weather condition, thereby causing a reduction in the cement (OPC) content required for the mortar. This gives room for the appreciation of nature, as Pozzolan can be sourced locally.

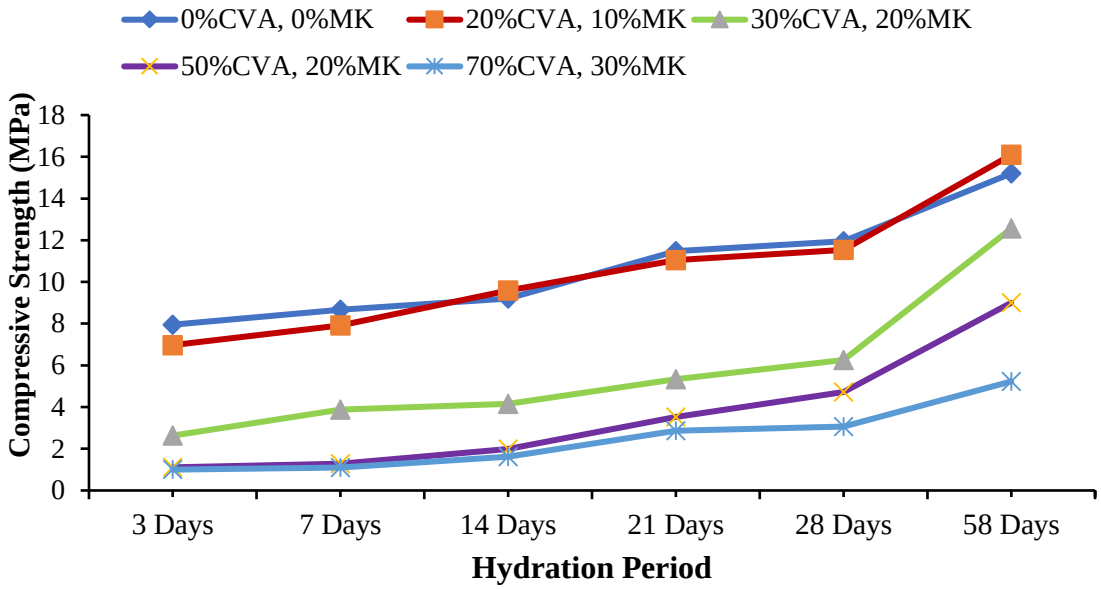

Fig 4: Compressive strength of 0.3 w/c mortar samples cured in air

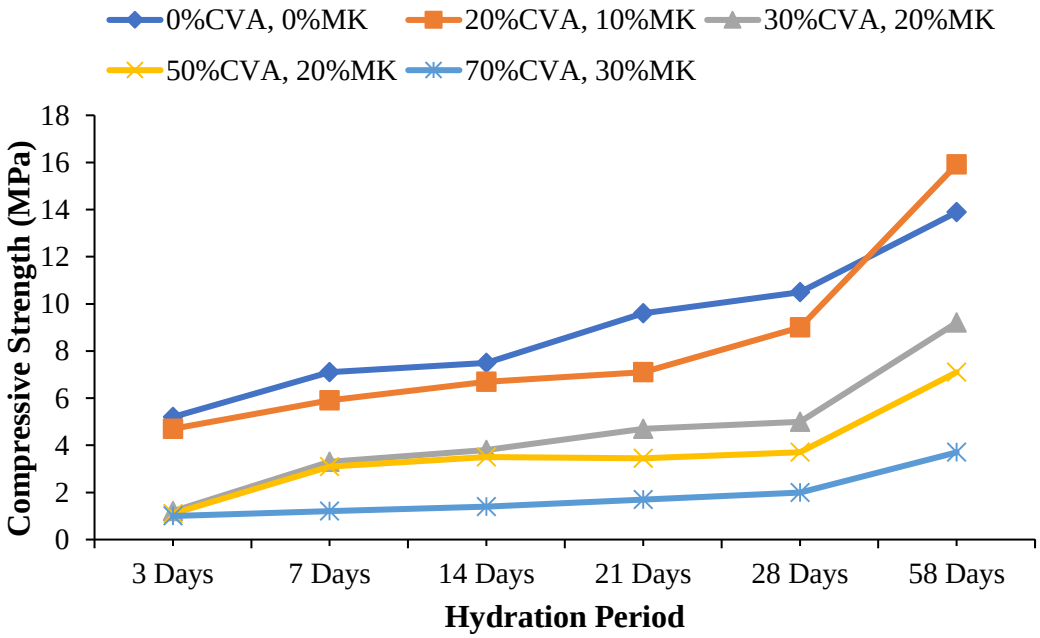

Figure 5: Compressive strength of 0.4w/c mortar samples cured in water

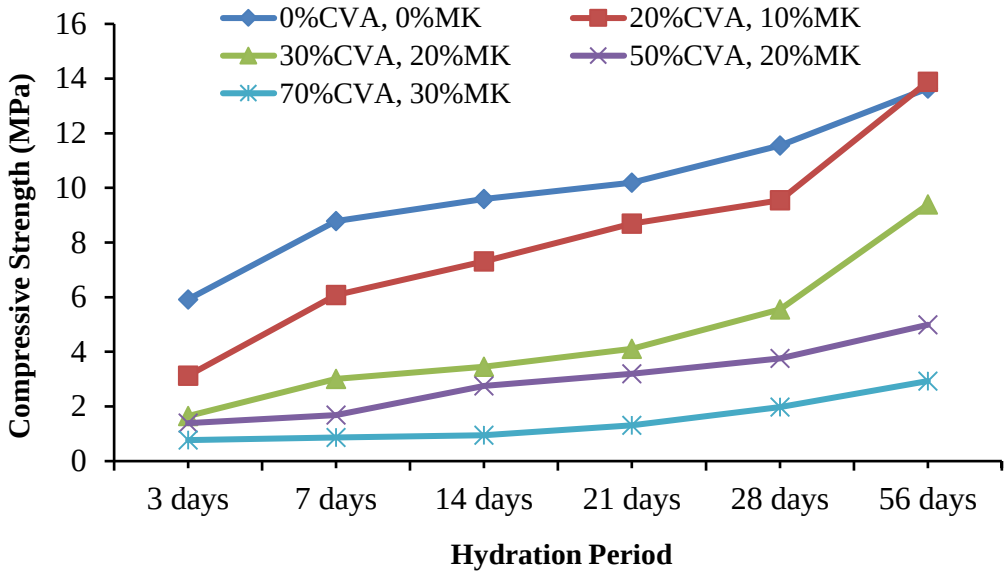

Figure 6: Compressive strength of 0.4w/c mortar samples cured in polythene bag

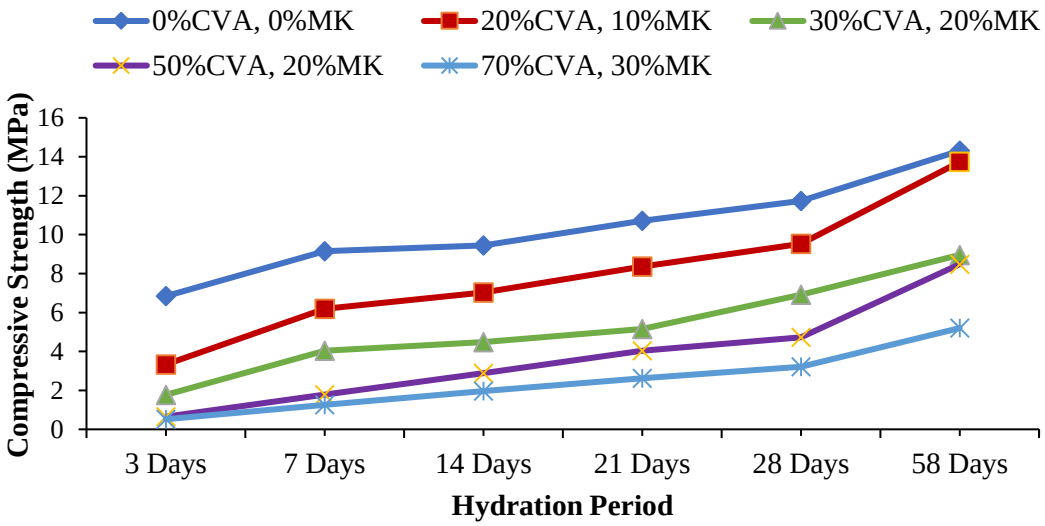

Figure 7: Compressive strength of 0.4 w/c mortar samples cured in Air

4.0 CONCLUSIONS

Based on the findings of the research carried out to examine the compressive strength characteristics of mortar specimens containing calcined volcanic ash and Metakaolin, the following conclusions were deduced:

1. The strength development pattern of the specimens produced with percentage replacement greater than 30% (20% PVA and 10%MK) generally slow and tend to decrease progressively as the percentage replacement increases to 100%.
2. Concrete specimens produced with 30% replacement, exhibited the highest compressive Strength values across all the three curing regimes (Water, Polythene and Air). Nonetheless, specimens cured under water gave the highest compressive Strength values for both 0.3w/c and 0.4w/c, which is closely followed by polythene bag curing while air curing is the least.
3. Concrete specimen produced with 30% (20% PVA and 10%MK) replacement and cured in water is therefore recommended as the most suitable for mortar production

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Piping Investigation of Kiri Dam Located in Shelleng L.G.A, Adamawa State, Nigeria, Using SEEP/W

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Abstract:
Dams fail through many ways. One of the most important causes of dam failures is excessive seepage. Excessive seepage causes piping which can cause dam settlement. Piping depends on many factors including nature of construction materials, reservoir water level, nature of the dam foundation and nature & efficiency of the seepage mitigation constructions like clay core and diaphragm wall. Piping through Kiri dam is studied by investigating hydraulic gradients and positions of phreatic lines using a software called SEEP/W which is a finite element based. Four sections that include CH 685, CH 800, CH 1000 and CH 1100 are considered for analysis. On each section, 36 different reservoir elevations that include monthly reservoir elevations of 1984, 1997 and 2003 are considered. From the analysis of the results piping was observed not be occurring. Therefore, the downstream surface of the dam remains dry and stable.

Keywords: Piping, SEEP/W, Kiri Dam, hydraulic gradient, phreatic line.

1.0 INTRODUCTION

Dams are constructed across rivers or streams to impound water at the upstream to serve many purposes such as flood control, water supply, irrigation, fisheries, recreational activities and many more. Kiri dam, located in Shelleng L.G.A, Adamawa state, Nigeria is an embankment dam constructed in 1979. It is 1400m long, 20m high, zoned embankment with a central clay core and an upstream blanket. It is geographically located on $9^0$40'47''N $12^0$00'51"E (Udo, 1970). Kiri dam is constructed across Gongola River which is the principal tributary of the Benue River (Tukur and Mubi, 2002). Kiri dam is expected to impound about 615 million cubic meters of water. The knowledge of the magnitude and effect of seepage through Kiri dam need to be studied. One of the effects of excessive seepage is piping.

Figure 1: Kiri Dam Reservoir (Source: Google maps)

Figure 2: Downstream face of the dam (Source: Self picture snap)

1.1 Piping

Piping, being one of the main causes of earth dam failures all over the world, occurs due to the constant migration of soil particles towards free exits, or into coarse openings which might occur through the earth embankment or its foundation soil (Omofunmi1 et al, 2017). The position of phreatic surface also determines the possibility of piping due to excessive gradient that is approaching unity. This causes softening and weakening of soil mass if it intersects the downstream slope (Dardabi et al, 2007. Voids are formed within an embankment by removing particles of the embankment materials during the occurrence of seepage. It is one of the leading failures in earth dam (Fell, et al, 2014). Hydraulic Forces exerted by seeping water through pores of dam and/or foundation detach the soil particles and causes the creation of a hole through the dam and/or foundation. The hole appears, usually, at the downstream face of the dam. Punmia and Lal, (1992), studied seepage through embankment dams and made the concluded that 40% of dam failure is attributed to hydraulic (internal erosion) failures, 30% to piping (resulting from seepage) while structural failure carried the remaining 30%.

Piping accounts for approximately 50% of all earth dams' failures (Lee, 2015). Arora, (2001) also showed that about 30% of dam failures are attributed to excessive seepage which may cause piping. Piping through the dam body, which, if not properly controlled, will cause dam settlement, thereby reducing the overall height of the dam body (Fell et al, 2014).

1.2 The Software (SEEP/W)

The use of analytical methods involved lengthy numerical calculations that are time consuming and error oriented due to approximations in computations and plotting for graphical and analytical studies respectively. In this research work a computer method of study was employed. Different types of softwares are developed for analysing seepage. The one that has been employed in this research work was SEEP/W, 2007. It is selected to be used for its ability

to handle both saturated and non-saturated conditions of embankment and for both steady and transient flow situation.

SEEP/W is a finite element CAD software product for analyzing groundwater seepage and excess pore water pressure, dissipated problems with porous material such as soils and rocks.

SEEP/W can be used to model the movement and pore-water pressure distribution within porous material such as soil and rock. Its comprehensive formulation makes it possible to analyze both simple and complex seepage problems. SEEP/W has applications in the analysis and design of geotechnical, civil, hydrogeological, and mining engineering projects. It is also a general seepage analysis program that model both saturated and unsaturated flow. The ability to model unsaturated flows allows SEEP/W to handle a wider range of real problems than many other software products.

Different researchers such as Beheshti et al, 2013, Sazzad et al, 2015, Soleymani and Akhtarpur, 2011, Goharnejad et al, 2016, have used SEEP/W to analyse seepage of different dams. Analyses of which include piping. Their findings were presented in different approaches.

2.0 MEHODOLOGY

2.1 Data Used

The data used for running the software are as follows:

Detailed drawings of the dam which include:

- Section of the dam at 685m
- Section of the dam at 800m
- Section of the dam at 1000m and
- Section of the dam at 1100m

CH 685, CH 800 and CH 1000 are selected for the analysis for having most of the instrumentation facilities of the dam installed on them. Section at CH 1100 is selected for the analysis for having a unique berm length longer that is longer that all the rest.

2.2 Materials Properties of the Foundation

The foundation of Kiri dam consists of thick alluvium deposit of about 65m depth under lain by bed rock with Bima sandstone as its main geological formation. The oldest material is consolidated, gray to dark gray, dense silty and silty clay, topped by a cemented nebula and grit conglomerate at a depth below river bed of 31 to 35 meters.

Table 1: Geological formation of Kiri Dam foundation

Formation Type	Depth from the Bed Rock (m)	Thickness	Hydraulic Conductivity (m/s)
Older layer of dark gray, dense silty sand and silty clay	0 – 32	35	1.5E -08
Younger Layer of silty sand and silty clay	32 – 48	16	2.65E-07
Sandy silts and clays	48 – 63	15	1.40E-7
Compacted sand	63 – 65	3	1.00E-6

Source: (WardAshcroft and Parkman Nig. 1977).

2.3 Materials Properties of the Embankment (Hydraulic Conductivity)

The younger layer of alluvium occupies a belt of about 375 meters wide and about 16 meters thick, comprising of sand and clays, mostly silty. Above this again, is a third layer of sandy silts and clays of about 15 meters thin of loose, mainly occupying a broad belt of 700 meters wide. Finally, there's a top layer of 3m sandy alluvium, eroded away completely except on the present banks and lying everywhere above the present river bed level.

Hydraulic conductivities of the construction materials are factors that are mainly responsible for the magnitudes of seepage velocity through embankment materials. The lower the conductivity values of the materials the lesser ability of the embankment material to allow the passage of seeping water and vise-versa. Therefore, embankment materials with low conductivities (clays and silty clays) are used as core and/or upstream clay blanket to minimize seepage. The embankment materials used in the construction of the dam have the following hydraulic conductivities

Table 2: Hydraulic conductivities of the construction materials

S/N	Material Type	Hydraulic conductivity(m/s)
1	Central clay core (Impervious Clay Core)	8.04E-09
2	Upstream blanket (Impervious Clayey Sand)	5.00E-07
3	Embankment (Pervious sand shell)	1.00E-06
4	Diaphragm wall (Impervious Clay)	7.00E-10

Source: (WardAshcroft and Parkman Nig. 1977)

2.4 Analysis Procedure

The procedure followed for achieving the seepage analysis using SEEP/W was as follows:

Setting the Working Space

The working area used for this analysis was 840mm width and 594mm high. A scale of 1:500 was used in both vertical and horizontal axes. Linear dimensions are set in meters while unit weight of water was considered as 9.80 kN/m^3. A grid spacing of 1m was adopted in order to conveniently sketch the dam geometries.

Sketching the Problem

In defining a finite element problem, the problem dimensions were first of all prepared. The 'sketch menu' was used as a guide for drawing the problem regions and defining its boundary conditions.

Generating Regions

In this analysis, 8 regions were generated

- Clay core
- Upstream blanket
- Diaphragm wall
- Pervious sand shell
- Foundation 1 (Older layer of dark gray, dense silty sand and silty clay)
- Foundation 2 (Younger Layer of silty sand and silty clay)
- Foundation 3 (Sandy silts and clays)
- Foundation 4 (Compacted sand)

Defining Materials' Properties (Hydraulic Conductivity).

Just as shown above, analyzing seepage through Kiri Dam involved the consideration of 8 regions. Each region has a hydraulic conductivity value that was defined. SEEP/W (2007) considered all the regions depending on its position and thickness to predict a seepage value through the dam in form of a volumetric rate. Hydraulic conductivity of the materials are as stated on table 3.2 and table 3.2

2.5 Problem Definition

Drawing regions

On each section, eight regions are drawn. They include four foundation regions, diaphragm wall, central clay core, upstream blanket and main embankment material region. Reservoir elevations of the 36 months (January to December in 1984, 1997 and 2003) measured by the dam operators were used for the analysis of sections at chainages 685m, 800m, 1000m and 1100m. The elevations ranges between 167.02m to 170.97m above mean sea level with free boards ranging between 3.53m and 7.48m. Zero pressure boundary is considered at the downstream toe. Potential seepage surface boundary condition is applied to the downstream face of the dam. This is called a potential seepage face. It is a special boundary condition that is used to locate where the seepage face might develop. A triangular pattern of meshing was adopted with each side of the triangle considered to be 3m. This was applied for 8 regions. The triangular pattern is selected to ease the meshing of the triangular oriented regions of the dam.

3.0 Results and Discusions

3.1 Phreatic Line

Out of all the sections studied, the phreatic line appeared not to be cutting the downstream face of the dam which would have a major reason for piping possibilities. Some of the studied sections are presented in Figure 5, Figure 6, Figure 7 and Figure 8. The figures displayed are those having highest reservoir elevations i.e 170.97m a.s.l. recorded in May 1997.

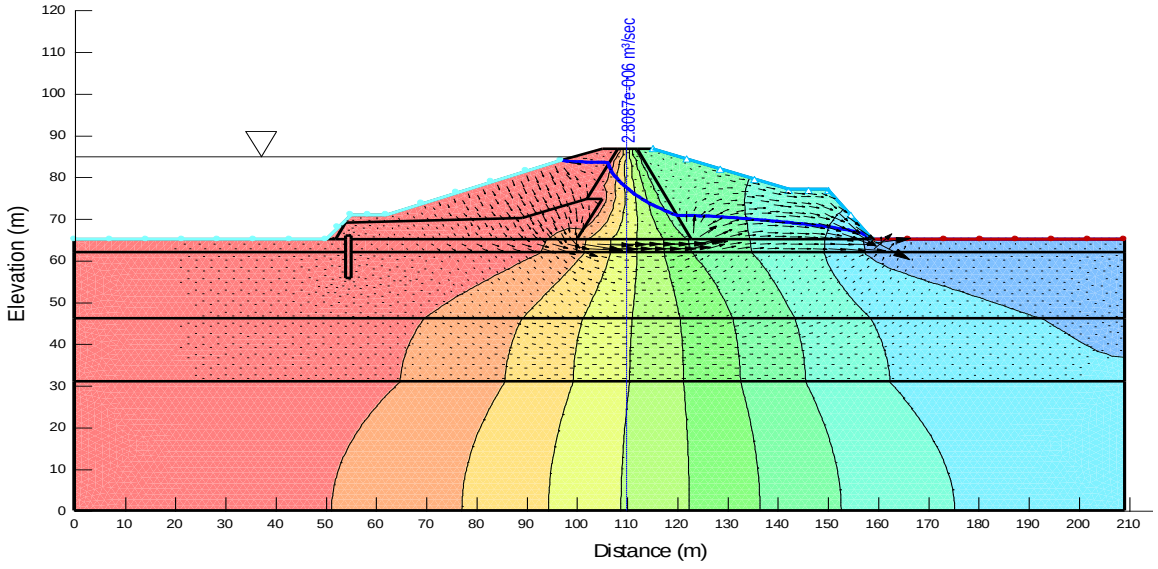

Figure 5: Flow path/velocity vectors of seepage at Ch685

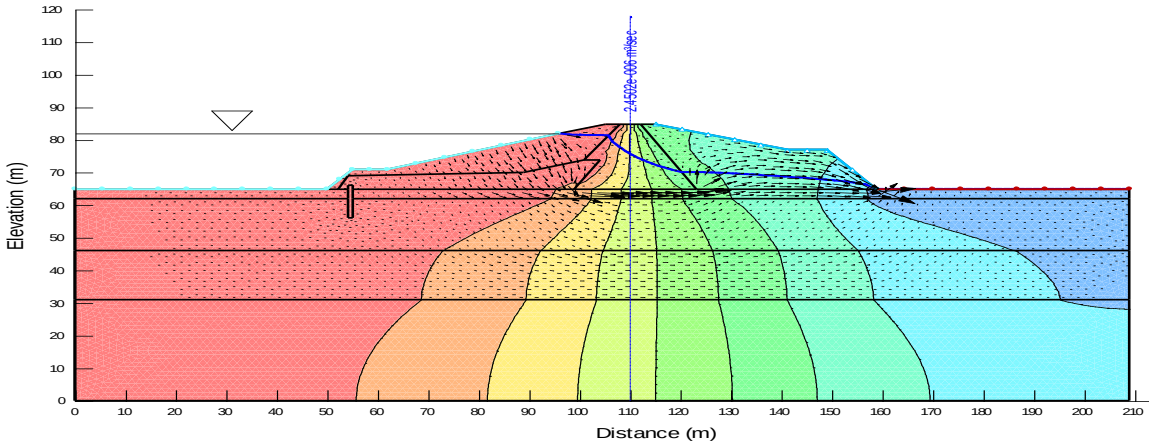

Figure 6: Flow path/velocity vectors of seepage at Ch800

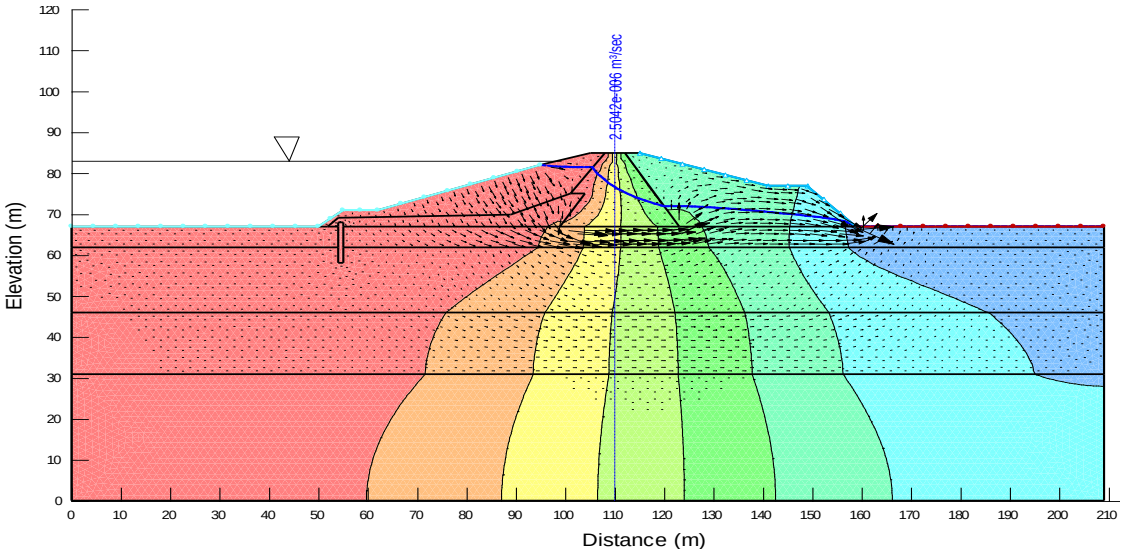

Figure 7: Flow path/velocity vectors of seepage at Ch1000

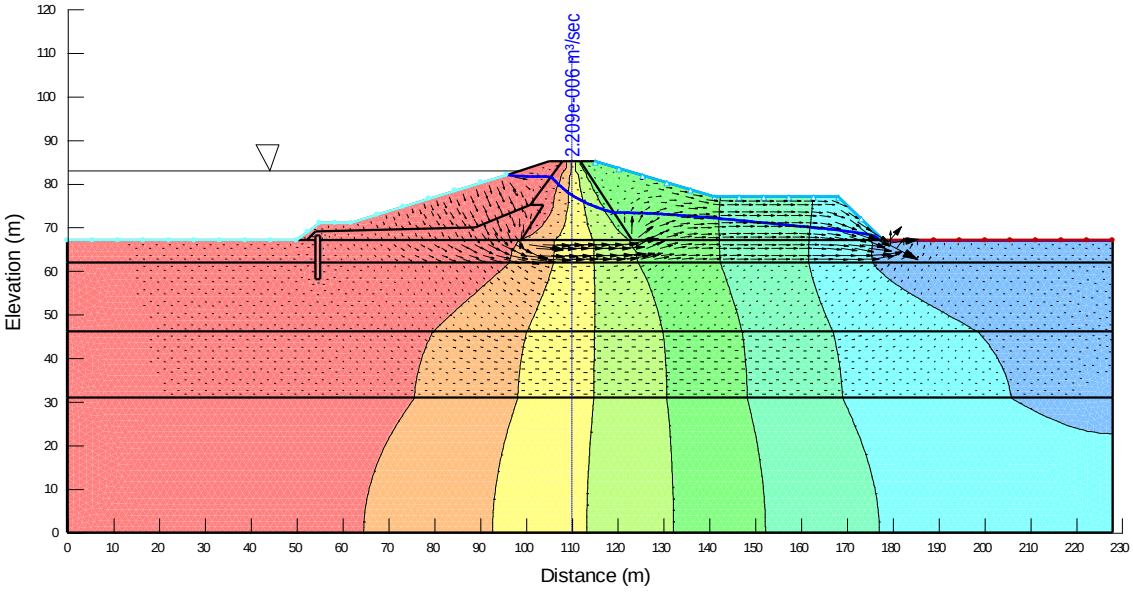

Figure 8: Flow path/velocity vectors of seepage at Ch1100

Hydraulic Gradient

Piping through an embankment dam is said to occur if the hydraulic gradient is equal to or greater than unity. It is expected to occur through the highly permeable embankment material. The highly permeable material is that of the shell and the upper layer of foundation for their hydraulic conductivities being 1.00E-06 m/s.

Table 3: Top 18 Nodal Hydraulic Gradients

CH 600		CH 685		CH 800		CH 880		CH 1000		CH 1100	
Node	Gradient	Node	Gradient	Node	Gradient	Node	Gradient	Node	Gradient	Node	Gradient
988	0.5336	988	0.5336	979	0.4561	979	0.4561	994	0.4324	987	0.3745
1005	0.4715	1005	0.4715	995	0.4861	995	0.4861	1011	0.4324	1003	0.3747
1007	0.5498	1007	0.5498	1011	0.6761	1011	0.6761	1012	0.3847	1020	0.5287
1020	0.5104	1020	0.5104	1013	0.5670	1013	0.5670	1025	0.2631	1024	0.4220
1022	0.7491	1022	0.7491	1029	0.7560	1029	0.7560	1027	0.6120	1040	0.5729
1039	0.8149	1039	0.8149	1045	0.5605	1045	0.5605	1029	0.4863	1042	0.5978
1055	0.7466	1055	0.7466	1046	0.8430	1046	0.8430	1046	0.6651	1055	0.4213
1056	0.6252	1056	0.6252	1062	0.6555	1062	0.6555	1062	0.4876	1058	0.6215
1072	0.7337	1072	0.7337	1075	0.4835	1075	0.4835	1063	0.7230	1074	0.4851
1089	0.5482	1089	0.5482	1093	0.5937	1093	0.5937	1094	0.4087	1089	0.5620
1121	0.8062	1121	0.8062	1109	0.4577	1109	0.4577	1113	0.5134	1106	0.4419
1122	0.5226	1122	0.5226	1111	0.6957	1111	0.6957	1129	0.3871	1108	0.6666
1137	0.6595	1137	0.6595	1127	0.5730	1127	0.5730	1130	0.6248	1124	0.5368
1156	0.5445	1156	0.5445	1129	0.7883	1129	0.7883	1145	0.5013	1129	0.4306
1157	0.7792	1157	0.7792	1144	0.4783	1144	0.4783	1163	0.6028	1141	0.6424
1172	0.6689	1172	0.6689	1145	0.6697	1145	0.6697	1164	0.4127	1147	0.5172
1188	0.3711	1188	0.3711	1161	0.5819	1161	0.5819	1180	0.5123	1164	0.4391
1190	0.6036	1190	0.6036	1177	0.5339	1177	0.5339	1198	0.4716	1182	0.4031

Nodes information are collected from the six sections studied. Reservoir elevation of 170.97m is considered for being the highest which also produced highest magnitudes of both hydraulic velocities and seepage fluxes. Consideration is made on portions of the sections that have higher concentrations of velocity vectors. The hydraulic gradients are tabulated below. The nodal hydraulic gradients ranged from 0.0001 to 0.8430from the 8444 nodes generated from the 4 sections studied. Top 18 hydraulic gradients from each section are presented in the table above:

CONCLUSIONS

Piping is said to occur through an embankment dam if two conditions are met; phreatic line cutting the downstream face and hydraulic gradient approaching unity. From all the 144 sections studied, the phreatic line didn't cut the downstream face. Moreover, out of all the 8,444 nodal information generated from all the sections studied, the hydraulic gradients ranged from 0.0001 to 0.8430, that is less than one. Considering these two cases of phreatic line not cutting the downstream face and hydraulic gradients being less than one, it can be concluded that, there's no piping occurring through Kiri dam and the downstream face of the dam is free of damp resulting from excessive seepage that leads to piping

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Assessment of Sustainable Traditional Building Materials to Modern Residential Housing in Ibadan, Oyo State, Nigeria

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Abstract:

The major problem facing housing industry today is the high cost of building materials. Yoruba speaking tribe of Nigeria have abundant traditional building materials such as clay, stones, laterite, bamboo, and timber that can be used innovatively in modern residential housing. The study aim to assess the sustainable traditional building materials, with the view to reduce the cost of constructing modern residential housing. The objectives of the study are to identify the sustainable traditional building materials and their usage in modern housing. The benefits, factors affecting their usage and ways to improve the quality of the materials were discussed. The study uses qualitative and exploratory research method. Review of relevant literature, field survey using open ended questionnaire, observation schedule were tools used to collect the information. 130 questionnaires were distributed and 100 questionnaires were returned. The study population were building professionals that make use of the sustainable traditional materials. Purposive sampling was used to select a sample of 100 respondents from the frame. Bar chart, frequency table, mean and percentage were statistical tools used to analyse the data. The study identifies 8 major traditional building materials available in Ibadan and the relevant literature reveals the innovative ways to use the materials. Reduced construction cost and affordable housing ranked high among the benefits while discrimination ranked high among the factors affecting their usage in modern housing. The study contributed to knowledge in usage and improvement on the quality of traditional building materials reduces construction cost and makes housing affordable.

Keywords: Assessment, Materials, Usage, Housing and Benefits.

INTRODUCTION

Afolabi and Olamide, (2012) stated that the movement of people from local settlement to urban areas resulted to increased population growth of various cities across Nigeria and this necessitate for more housing in Ibadan, Oyo State, Nigeria. As such, Gumel (2000) observed that to construct modern housing in Nigeria, building materials account for 55% to 65% of construction cost and most of the materials used were imported materials. Several factors like foreign exchange rate, import duties and inflation also contributed to the high cost of the building materials. Therefore Ademiluyi (2010) suggested the need to shift attention towards the usage of sustainable traditional building materials to reduce the cost of building construction and improve the affordability of modern housing. Furthermore, Ibem (2010) stated that the past and present governments in Nigeria, expressed interest in the provision of affordable modern residential housing for the people using less expensive, sustainable, traditional building materials. The paper aim to assess the sustainable traditional building materials in Ibadan with the view to reduce the cost of constructing modern residential housing in Oyo State. The study identifies 8 sustainable traditional building materials available and their usage in modern residential housing in Ibadan, Oyo State. Factors affecting their usage, benefit and ways to improve the quality of the traditional building materials were discussed and analysed. The study uses qualitative and exploratory research method. Review of relevant literature and field survey using open ended questionnaire and observation schedule were used as instrument to collect data. Out of the 130 questionnaires that were distributed, only 100 questionnaires were returned. The study population were building professionals in the built industry that make use of the sustainable traditional building materials in Ibadan. Purposive sampling was used to select a sample of 100 respondents from the frame. Statistical tools like Bar chart, frequency table, mean and percentage were used to analyse the data from field study. The study is necessary as it contributes to knowledge in area of usage and improvement on the

quality of the traditional building materials also reduces construction cost and makes modern housing more affordable for people.

LITERATURE REVIEW

Traditional Building Materials

Akeju (2007) observed the abundant sustainable traditional building materials available in Ibadan, Oyo State, Nigeria that can reduce the cost of housing construction. Unfortunately, some of the materials were underutilized and considered socially unacceptable to people. As such, Akeju (2007), Olayiwola and Ademiluyi (2010) emphasis the need to adopt the usage of the sustainable traditional materials to create more affordable housing in Nigeria. For example, Adedeji (2005) stress the need to use mortar less masonry blocks compared to conventional sand Crete blocks in modern residential housing construction as it encourages standardization of building component, cost effective and promotes sustainable modular design. The mortar less block is also known as hydra form block and is made locally from soil and cement. Alagbe (2010) suggested the need to use other traditional materials innovatively in modern residential housing just like the way hydra form blocks were used extensively in Ugada, South Africa, Ethiopia and other Africa countries. Akeju (2007), and Alao L.O (2017) listed and discuss the existing sustainable traditional building materials available for modern housing in the study area as:

I. **Stone**: Akeju (2007) stated that stone is naturally occurring and are abundant in Nigeria.

Plate 1: Shows granite stones used for construction. Source: Alao L.O (2021)

II. **Bamboo and Thatch Materials:** Alao L.O (2017) discuss bamboo as a pole like structure that is mostly used for roof, slab support and fence construction. Both bamboo and thatch materials were available abundantly in south western part of Nigeria.

Plate 2: Shows pictorial view of bamboo. Source: Alao L.O (2017)

III. **Mud**: Alao L.O (2017) defines mud as earth mixed with liquid and it is found extensively in rural areas. It serves as good heat insulator. Mud is also a semi fluid material and can also serve as a binder.

Plate 3: Shows wet sticky mud. Source: Alao L.O (2017)

IV. **Timber**: Alao L.O (2017) stated that Timber is safe to handle and it is naturally anticorrosive. It is cost effective and also widely available in the south western part of Nigeria.

Plate 4: Shows pictorial view of Timber. Source: Alao L.O (2017)

V. **Clay**: Google Wikipedia (2021) stated that clay is widely available and can be found in towns and villages across south western Nigeria. Clay soil is a fine mineral particle with less organic material and is very sticky when wet. It is very cheap and also sustainable.

Plate 5: Shows clay soil. Source: Google Wikipedia (2021)

VI. **Laterite**: Google Wikipedia (2021) stated that laterite is another very good sustainable traditional material widely available in the south western part of Nigeria. Laterite is a highly weathered, natural, red coloured, soil material due to high concentration of hydrated oxides of iron or aluminum.

Plate 6: Shows laterite soil Source: Google Wikipedia (2021)

VII. Gravel: Alao L.O (2017) stated that gravel is a small loose rock particle larger than 2mm and smaller tha1/12 inch and is not more than 2.5inch or 64mm. it is readily available in south western Nigeria.

Plate 7: Shows mass gravel. Source: Google Wikipedia (2021)

VIII. Sand: Google Wikipedia (2021) defines sand as a granular material composed of finely divided rock and mineral particles smaller than gravel and course than silt. It is also very abundant in the study area.

Plate 8: Shows pictorial view of sand. Source: Google Wikipedia (2021)

Furthermore, Fisk (1982) and Kadiri (2005) stated that apart from reduced construction cost and affordable housing which ranked high among the benefits of using traditional building materials, other benefits of using sustainable traditional building materials are: high sound insulation, flexibility, availability, recyclability, fire resistant, inexpensive, simple and ease of usability. However, despite the benefit associated with the aforementioned sustainable traditional building materials, several factors still affects its usage in modern residential housing in Ibadan, Oyo state Nigeria. Adogbo and Kolo (2013) stated that discrimination in the usage of the local materials lead to the general public doubting its durability, reusability, and aesthetic. Adogbo and Kolo (2013) identify and listed other factors affecting it usability in modern housing as:

I. **Use of Inappropriate Technologies:** Decrease in the use of local building materials has led federal government in the past to establish large scale factories to produce basic building materials. Unfortunately, most of the factories faced many difficulties as a result of inappropriate use of technical know-how. Adogbo and Kolo (2013)
II. **Capital**: The greatest challenge to small scale commercial production of local building materials is the difficulty to raise capital in Nigeria. High interest rate affects the prices of finished product. Adogbo and Kolo (2013)
III. **Government Policy**: The growth of this sector is mostly affected by inadequate recognition and support when it comes to policies and regulations that aid the sector.
IV. **Legal Issue**: Lack of flexibility of existing regulation is a barrier to its use in housing construction in urban cities Nigeria. Building regulation Codes need to be revised and modified to permit the use of Compressed Stabilized Earth blocks technologies and other innovative methods of using local materials. Adogbo and Kolo (2013)

Therefore,Adogbo and Kolo (2013) suggested several ways to improve the quality of traditional building materials by establishing specification and standards, educating the client and the general public to think in terms of building their residential houses with sustainable local materials. Revision of building codes in order to incorporate the indigenous building materials in modern residential housing and Improved production method through the use of advanced technology and skilful workers to manufacture the building materials.

Innovative Ways to Use Traditional Building Materials

Dimoniaku and Obiozo (2010) discussed other innovative ways to use traditional building materials as discussed below:

Laterite, clay and mud soil : can be used innovatively inform of hydra forms blocks, compressed stabilized earth blocks (CSEB), Stabilized mud blocks, brick panel, blocks, and hollow clay pot, and used as filler materials in wall and floor construction. Plate 3, shows a solid concrete slab 50mm slab thickness, a filler hollow brick 100mm serves as alternative to concrete which cost one third of concrete. This means that 15 to 20perct of the cost of concrete slab had been saved using this method.

Plate 9: Cross section of hydra form blocks. Source : Dimoniaku and Obiozo (2010)

Plate 10: Shows hollow construction bricks use in the construction of first floor of a five bedroom Duplex Apartment, in Ibadan, Oyo state Nigeria. .
Source: Author field work (2021)

I. **Stones**: are used innovatively in form of marble, limestone and granolithic wall and floor finishes.
II. **Timber**: Asbestos, plywood, and other natural fiber materials are all produced from timber.
III. **Bamboo and Thatch materials**: can also use innovatively in the construction of modern gazebos for recreation purpose.

METHODOLGY

The study uses qualitative and exploratory research method. Review of relevant literature, field study using open ended questionnaire and observation schedule were tools used to collect data from field study. Out of the 130 questionnaires that were distributed, only 100 questionnaires were returned. The study population were the building professionals in Ibadan from Federal, State ministry of works and Housing, town planning department, construction firms, architectural design firms, and lecturers from faculty of environmental in the polytechnic Ibadan Oyo state, Nigeria. Purposive sampling technique was used to select sample size of 100 building professionals and 8 major traditional building materials were identified from the sample frame. The questionnaire covers the respondents profile in terms of profession and general knowledge regarding the research aim and objectives. Respondents were asked open ended questions in regard to the usage of the sustainable traditional building materials that exist abundantly in Ibadan. The benefits of using the materials, factors affecting the usage of the

aforementioned materials and ways to improve their quality were asked from the respondents based on the 8 major selected traditional materials from the relevant literature. The statistical tools use to discuss and analyse the results were pie chart, bar chart, mean, frequency Table and percentage.

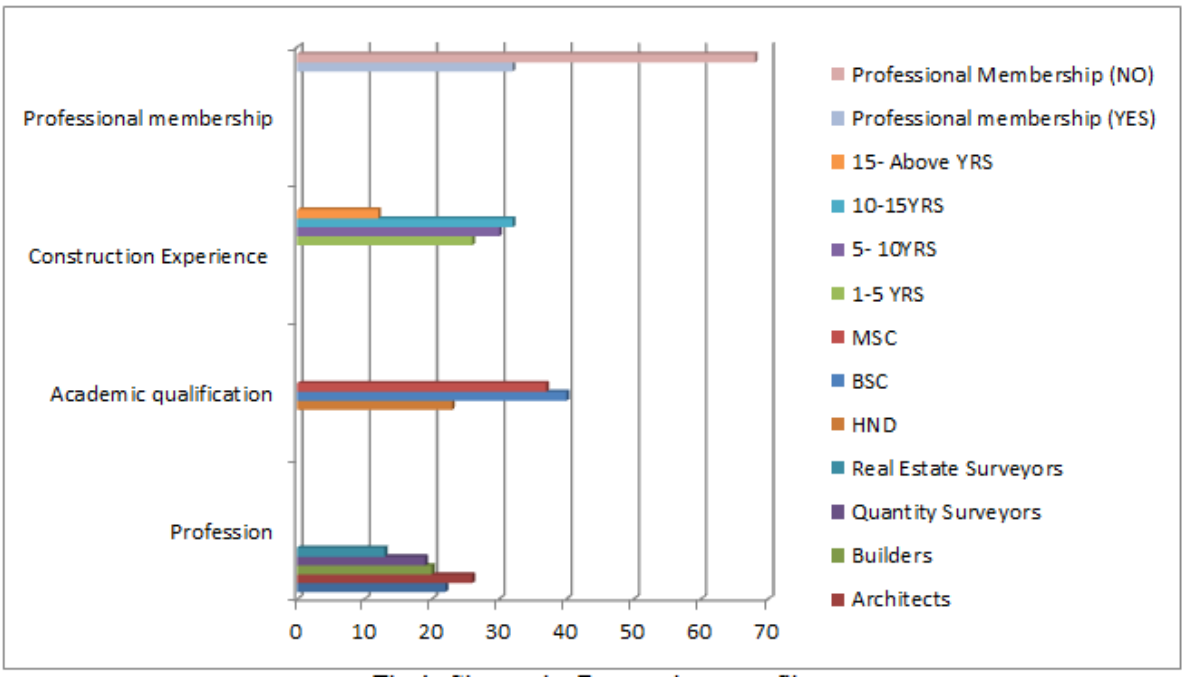

Figure 1: Show the Respondents profile. Source: Author field work (2021)

Figure 1 shows the respondents' profile. The total number of respondents was 100. Out of the total number mentioned: 22 respondents were trained civil engineers, 26 were professional architects, 20 were Builders, 19 were Quantity surveyors and 13 were real estate surveyors. More also, 23 respondents have HND (higher national Diploma) 40 have BSC (Bachelor degree) and 37 have MSC (Master's degree). Furthermore, 26 respondents have 1-5 years, 30 respondents have 5-10 years. 32 respondents have 10-15 years, and 12 respondents have 15 years and above construction experience in their various professions. Also 32 respondents registered with a professional body, while 68 respondents do not registered with any professional body apart from the academic qualification they possess.

RESULTS AND DISCUSSION

Figure 2 and 3 reveals the building materials percentage availability and their level of usage in the study area. 100% of the selected respondents agree that there is large abundant of stones, laterite and timber in the study area. 65% agree with availability of bamboo and thatched materials, 68% respondents agree with availability of Clay and gravel, 50% respondents agree with the availability of mud and 75% respondents agree with availability of sand in Ibadan, Oyo state Nigeria.

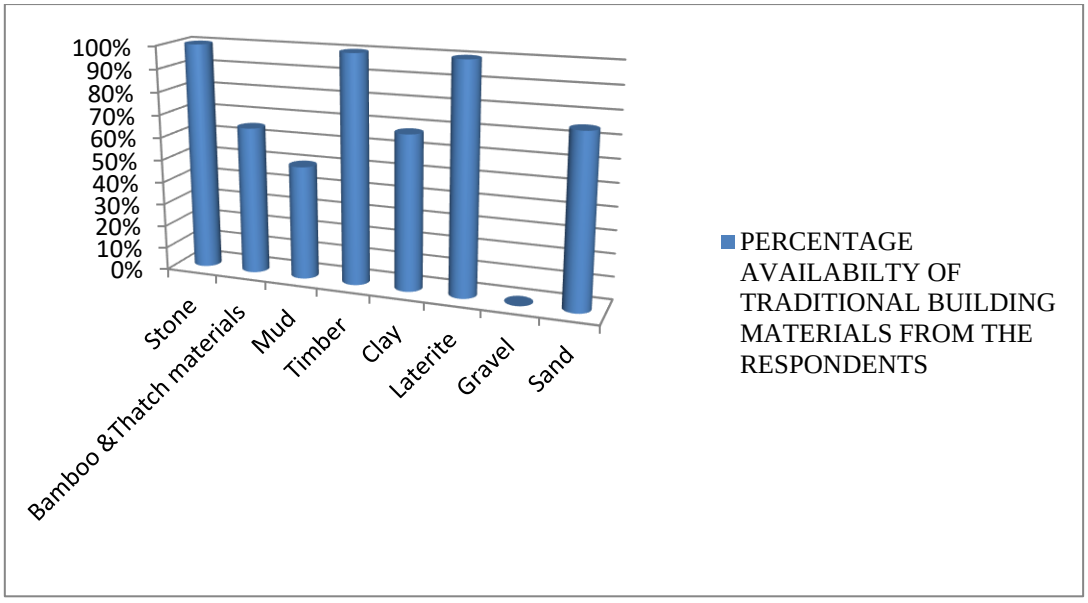

Fig 2: Chart shows respondents thought in terms of percentage availability of sustainable traditional materials available in Ibadan, Oyo state Nigeria. Source: Author field work (2021

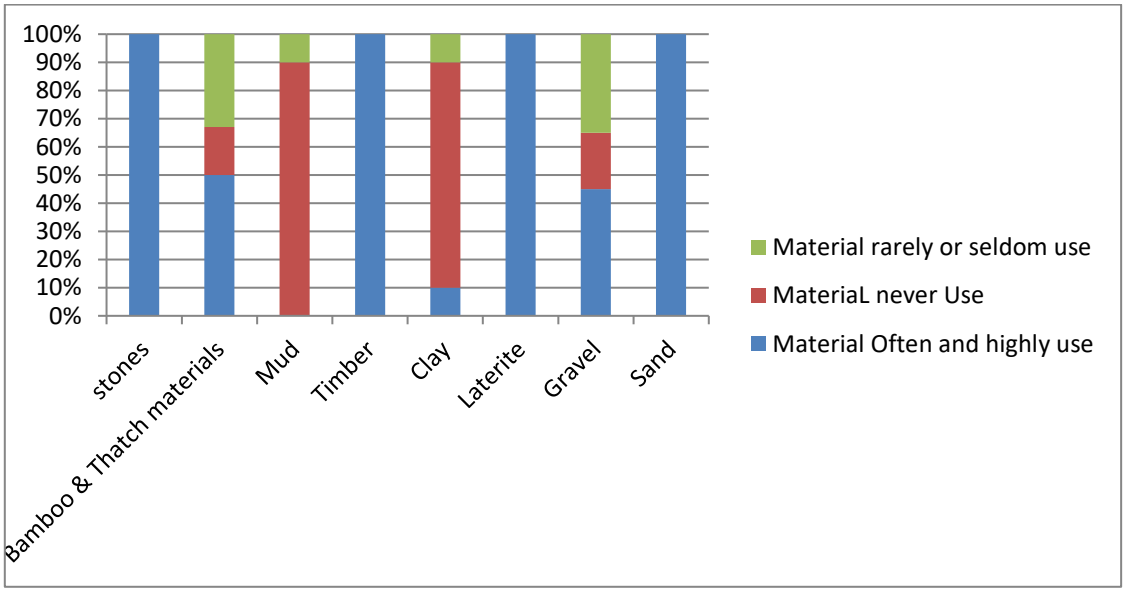

Fig 3: Shows respondents thought in regard to the usage of sustainable traditional materials available in Ibadan, Oyo state Nigeria. Source: Author field work (2021

Plate 3 reveals that the entire 100 respondents selected concur and agree100% that stones, timber, laterite, and sand were the highly use building materials in Ibadan. Concerning bamboo and thatched materials, 50% respondents believe that it is highly use, 17% believe it is never use, while 33% believe it is rarely or seldom use. 70% respondents believe that clay is never use in Ibadan, while 10% believes that clay is either often use or rarely use. Furthermore, 90% participant believes that mud is never use as building material in modern housing, while 10% participant believes it is rarely or seldom use. 45% respondents agree and believe that gravel is highly use in the study area, 20% believes it is never use, while 35% participants believe it is rarely or never use.

Table 1: The Respondents Thought on Factors Affecting the Usage of the Aforementioned Sustainable Traditional Building Materials Using Likert's Scale. Source : Author field work (2021)

Factors Affecting The usage of Traditional Building Materials	Total no of respondents	SA 1	A 2	SD 3	D 4	Mean	Rank order	Consensus Agreement
Discrimination: (Durability and Re-usability doubted)	100	70	30	0	0	1.3	1	Strongly agree
Capital	100	40	60	15	0	2.05	2	Agree
Aesthetic	100	30	50	10	10	2.0	4	Agree
Use of inappropriate technology	100	20	15	20	45	2.9	6	Disagree
Government policy	100	55	30	5	10	1.7	3	Agree
Legal Issue	100	20	20	30	30	2.7	5	Disagree

Note: The mean Ranks =: (0 – 1.59) = Strongly agree, (1.6 -2.69) = Agree, (2.7 - 3.59)= Disagree, (3.6 -4.59) = strongly disagree.

Table 2: The Respondents Thought on the Benefits of Sustainable Traditional Building Materials Using Likert's Scale. Source : Author Field Work (2021)

Benefit Associated With The Use of Traditional Building Materials	Total no of respondents (N)	SA 1	A 2	SD 3	D 4	Mean	Rank Order	Consensus Agreement
Reduce cost of Construction	100	80	20	0	0	1.2	1	Strongly agree
Affordable modern housing	100	78	22	0	0	1.22	2	Strongly agree
Availability	100	75	25	10	10	1.95	4	Agree
Durability and sustainability	100	40	45	5	10	1.85	3	Agree
Flexibility	100	30	40	18	12	2.12	8	Agree
High Sound insulation	100	20	20	40	20	2.6	9	Agree
Recyclability	100	30	45	15	10	2.05	7	Agree
Fire Resistant	100	30	50	10	10	2.0	5	Agree
Reusability	100	30	48	12	10	2.02	6	Agree

Note: The mean Ranks =: (0 – 1.59) = Strongly agree, (1.6 -2.69) = Agree, (2.7 - 3.59)= Disagree, (3.6 -4.59) = strongly disagree.

Table 1 and 2 reveal the respondents thoughts on factors affecting the usage of traditional building materials and benefits associated with the usability of the materials. Result analysis from table 1 shows that majority of the respondent support the study carried out by Adogbo and Kolo (2013) that discrimination against the use of traditional Building materials is the major factor affecting it usage in modern housing based on the mean rank and consensus agreement or opinions of the respondents. Table 2 also reveals that the majority of the respondents strongly agree with Fisk (1982) and Kadiri (2005) studies that reduced cost of construction and affordable modern housing are the major benefits of using traditional building materials.

Finally, the results from table 3 support and justify the works of Adogbo and Kolo (2013) suggestions that specification and standardization of building materials, educating the clients

and general public, revision of building codes, improved production method through research and training, and use of advanced technology and skilled workers were major ways to improve the quality of sustainable traditional building materials.

Table 3: The Respondents Thought on Ways to Improve Sustainable Traditional Building Materials Using Likert's Scale. Source : Author Field Work (2021)

Ways to Improve The Quality of Traditional Building Materials	Total no of Respondents	SA 1	A 2	SD 3	D 4	Mean	Rank Order	Consensus Agreement
Specification and standardization of building materials	100	65	30	0	10	1.65	5	Agree
Educating clients and General public	100	80	20	0	0	1.2	1	Strongly agree
Revision of building Codes	100	55	40	0	5	1.55	3	Strongly Agree
Improved production method through research and training	100	60	40	0	0	1.6	4	Agree
Advanced Technology and use of skilled workers	100	55	45	0	0	1.45	2	Strongly agree

Note: The mean Ranks =: (0 – 1.59) = Strongly agree, (1.6 -2.69) = Agree, (2.7 - 3.59)= Disagree,(3.6 -4.59) = Strongly disagree.

CONCLUSION

The study reveals lot of findings through field study and literature review which will form the basis of recommendation. A lot of sustainable traditional building materials were available in Ibadan with some highly use, some never use and others are rarely or seldom use. Laterite, sand, stone and timber are the most highly use sustainable building materials in Ibadan, Oyo State, Nigeria probably because of the large availability. Literature reveals many ways to use the identified traditional materials innovatively in modern housing. As such, professionals and other stake holders in the building industry should extend their use to the remaining available sustainable traditional building materials that were never use in Ibadan. Producer of sustainable modified building materials should take cognisance of the factors affecting the usability of the traditional building materials mentioned above during production stages to enhance the product output in modern residential housing. Provision of affordable housing reduction of construction cost, durability and sustainability, and availability ranked high among the benefits of using sustainable local materials. As such, professionals in the built industry should take advantage of the abundant traditional materials in the study area during building construction to meet housing needs of the people. Finally, the study also recommends the results from Table 3 that the quality of the sustainable traditional building materials should be improved through : specification and standardization of building materials, educating the clients and general public on the need to use traditional building materials during construction, revision of building codes, improved production method through research and training, and use of advanced technology and skilled workers during production stages of the modified materials.

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Evaluation of the impact of the Use of Roof Concrete Fascia on Embodied Carbon Emission of Residential Buildings in Nigeria

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Abstract
*The study investigated the implications of the use of concrete eave fascia on the embodied carbon emission of residential buildings. The use of concrete fascia has become a trending aesthetic component of residential buildings in most cities in Nigeria, hence the need to understand the environmental implications. The study employed the Life Cycle Carbon assessment approach for 60 years of service life. The study found that the use of concrete eave fascia increased the embodied emission with an average value of 4,551.34 Kg CO_2 (5.0%)**.** In line with IUA vision 2050 which is to achieve zero CO_2 emission in buildings, the paper suggests that the use of concrete eave fascia be discouraged**.***

Keywords: *Building, Carbon, Environment, Sustainability, Roof eave,*

1.0 INTRODUCTION

The use of concrete fascia has become a trending aesthetic component of residential buildings in most cities in Nigeria. The trend has also created street caps of buildings with different designs of roof concrete fascia often finished with bright and appealing colors. According to Alozie (2019), the demand for building with concrete fascia is fast increasing and the movement has brought about redesigning and reconstruction of old buildings in Nigerian cities. Roof concrete fascia is described as the vertical frieze or band under a roof eave that makes up the outer surface of a cornice, noticeable to viewers. Alozie, Eze, Ifebi, & Nnsewo (2019) added that it is that part that hides the rafter projections carrying the roof eave extending out 300-500mm and substitutes the visible eaves as contained in conventional gable roofs. Construction of concrete fascia can be precast or cast in situ with reinforcement bars as shown in figure 2. The additional building material resulting from the use of concrete fascia has raised environmental sustainability issues. Existing studies have identified that the major environmental loads associated with building materials/construction methods are embodied energy of building materials and associated carbon emissions from the various phases of their life-cycle (Sodagar, Rai, Murphy, & Altan, 2009; Adedeji, 2012). As a result, vision 2050 of the International Union of Architects -IUA is geared towards emission-free and low-energy buildings (Ezema, Opoko, & Oluwatayo, 2016).

An earlier study by Udomiaye & Chukwuali (2018) and Ezema et al (2016) reported that the embodied carbon intensity of the Nigerian housing sector is significantly high when compared with studies in the developed countries. The above-stated findings underscore the need for further investigation into the trending architectural design and construction methods such as the use of roof concrete fascia. Therefore, the paper aims to evaluate the effects of roof concrete facia on embodied carbon emission in residential buildings using Life Cycle CO_2 Assessment ($LCCO_2A$) with the view of identifying the implications of design decisions of architects. The objectives are to; estimate the embodied emission of the selected referenced building, determine the percentage emission from the roof and carry out a sensitivity analysis by replacing concrete fascia with conventional roof wooden fascia. Life Cycle CO_2 assessment is an aspect of Life Cycle Assessment (LCA), an approach for evaluating the environmental impacts of products or processes during their whole life cycle. Greenhouse gases are the weightiest emissions to the environment of which carbon dioxide is the most prevalent gas and thus it is considered a threat to global warming and climate change (Resch, Lausselet , Brattebø

, & Andres, 2020). The knowledge of carbon emission in buildings and its assessment framework is fundamental to understanding the implications of architect's decisions with regards to the impact on the environment. The study is quantitative, and it considers the material flows, and associated greenhouse gas.

Fig. 1: Roof Concrete Eave Fascia.
Source: Author's fieldwork

Fig 2: Conventional Roof Wooden Eave Fascia.

2 .0 MATERIAL AND METHOD

There are three generally pragmatic methodologies to estimate the embodied CO_2 emissions in buildings these are: The process-based method, the input-output (I–O) analysis, and the hybrid method. The study adopted the process-based method, which is an approach that uses process flow to consider different activities associated with a building (Taffese & Abegaz, 2019) and it is the most applied methodology to assess the impact of embodied energy and CO_2 emissions at different levels. For a good understanding of the discussion, Life-Cycle Embodied CO_2 Assessment (Process-Based) is demonstrated using a residential building project located in Abakaliki, southeastern Nigeria. To determine the impact of the use of concrete eave fascia on the embodied carbon emission from residential buildings, sensitivity analysis was done by replacing the wooden roof eave fascia with roof concrete eave fascia. Data were obtained from the existing studies, drawings, bill of quantity, interaction with the contractor, and Inventory of Carbon and Energy (ICE) of the University of Bath. Detailed procedure is provided in section 2.2. There are numerous cases of LCA studies on different buildings (Mastrucci, Marvuglia, Leopold, & Benetto, 2017), thus, provides opportunities to make use of data from earlier studies.

2.1 Life Cycle CO_2 Assessment ($LCCO_2A$) Studies

Current studies have proved that the percentage of embodied energy and CO_2 emissions is increasing compared with operational energy and CO_2 emission (Sturgis & Roberts, 2010). Several empirical studies on carbon emissions emanating from energy consumption and resource use at the building level exist in literature at the local and international levels. In a Nigerian study, Udomiaye et al (2018) reported that roof covering accounted for an average of 7.6% of the initial embodied emission while the major components of embodied emissions were the cradle-to-gate emissions accounting for an average of 63%. An Egyptian comparative study of the embodied carbon intensity of vernacular and contemporary buildings reported that vernacular buildings with materials sourced from the building context can attain up to a 60% decrease in embodied carbon emissions when compare with contemporary buildings (Ali, Hagishima , Abdel-Kader, M, & Hammad, 2013) . Abanda, Nkeng, Tah, Ohandja, & Manjia (2014) examined cradle-to-gate embodied energy and CO_2 emissions in mudbrick and cement-block houses in Cameroun using ICE database and reported CO_2 intensities to be $228kgCO_2/m^2$

and 397 $kgCO_2/m^2$ respectively for the study area. In South Africa, Dumani & Ampofo-Anti (2015) appraised cradle-to-gate energy and GHG emissions of concrete and steel re-bars. The study found that concrete particularly the cement content and steel re-bars contributed substantially to CO_2 emissions.

2.2 Estimating Embodied CO_2 Emission in Buildings

The term 'embodied carbon' refers to the lifecycle greenhouse gas emissions (expressed as carbon dioxide – CO_2) that occur during the manufacture and transport of construction materials and components, as well as the construction process itself and end-of-life aspects of the building including demolition, reuse, and recycling. In the mathematical expression, embodied emission is the total of initial embodied emission and recurring emission, whereas initial embodied emission is the total of material embodied emission, site construction emission, and transportation as represented by equation 1.

$$EE_i = EE_M + EE_T + EE_C \quad (1)$$

Where; EE_i = initial embodied emission, EE_M = embodied emission of material (cradle – to – gate), EE_T = embodied emission of transportation (gate – to – site), EE_C = site construction emission. Cradle-to-gate material embodied emission (EE_m) is expressed in equation 2.

$$CEM = QM \times ECC \quad (2)$$

Where CEM = carbon emission of material, QM = quantity of material, and ECC = embodied carbon coefficient. The quantities of materials gotten from a standard bill of quantities (BQ) were designated in units of measurement compliance with the ICE inventory. Construction or site emission consists of CO_2 emission from machine and electricity consumption. Therefore, carbon emission for direct fuel combustion was estimated using the formula:

$$C_{EF} = A \times E_C \quad (3)$$

Where C_{EF} = carbon emission from direct fuel consumption, A = activity data (litres of fuel), E_C=emission coefficient ($kgCO_2$/litre of fuel). Also, emission from grid electricity was calculated using the formula:

$$C_{EGE} = E_C \times E_{EF} \quad (4)$$

C_{EGE} = carbon emission for grid electricity, E_C = electricity consumption and E_{EF} = electricity specific emission factor.

The total embodied CO_2 is the summation of initial embodied emission and recurring or maintenance emission as expressed in equation 5

$$EE = EEi + EE_{rec} \quad (5)$$

Where EE= total embodied CO_2, EEi = Initial embodied CO_2eq emission and EE_{rec} = Recurring or maintenance carbon emission. Recurring or maintenance emission is the CO_2 emitted during building maintenance all through the useful life of the building. The recurring embodied emission is made up of the embodied emission of the materials used for the maintenance and associated transportation emission. The recurring CO_2 emission is represented in equation 6. Recurring embodied emission is the maintenance energy:

$$EE_{rec} = \sum Q_M EE_{CF} [(LB/LM) - 1] \quad (6)$$

Where; EE_{rec} = recurring embodied emission. Q_M = quantity of building material, EE_{CF} = embodied emission coefficient of material per unit quantity, LB = life span of the building, LM = life span of building material.

3. RESULT AND DISCUSSION

3.1 Cradle –to- Gate Embodied Carbon Emission

The embodied CO_2 of the reference case study through the materials used for construction emits ***63,343.96 kgCO_2***, which is approximately 63.3 tons of CO_2. The superstructure accounted for most of the emissions of the reference buildings, accounting for 47.7% followed by internal and external walls and Wall finishes contributing 27.5% and 6% respectively, while the roof structure emits 5%. Doors/Windows, floor finishes, ceiling finishes, paintings, and services contributed a total of 18.6%.

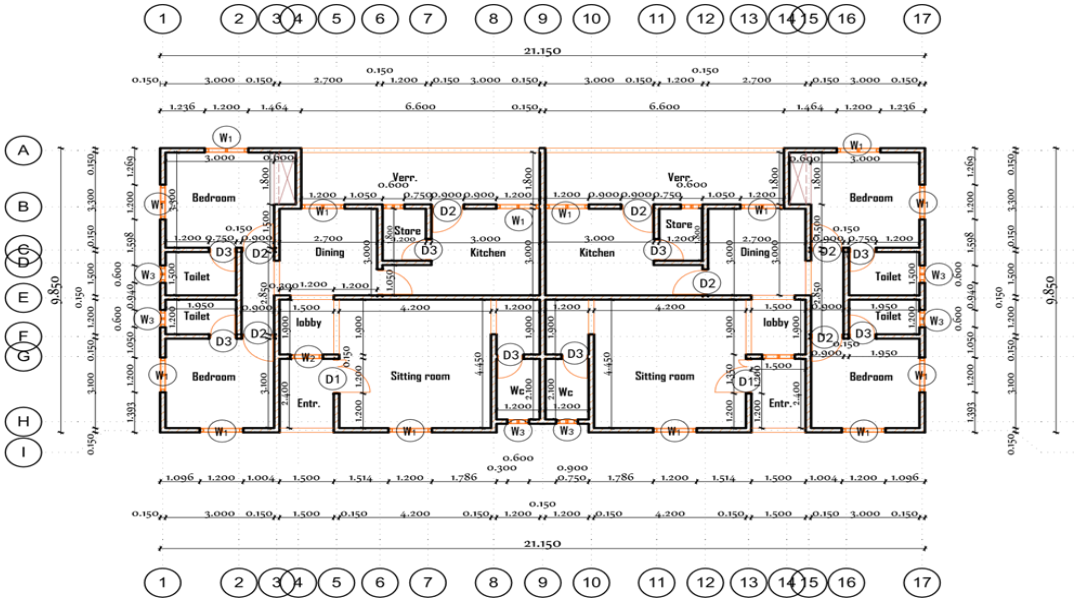

Figure 3: Ground Floor Plan Two Bedrooms apartment building Sakamori Estate, Abakaliki.

Table 1. Gate –to-Gate Material Embodied GHG Emission (CO_2)

Detailed Cradle – to – Gate Embodied Carbon Computations				
No	Building Component	Embodied Carbon Emissions (KgCO2)	Embodied GHG Emissions (KgCO2eq)	Percentage %
1	Substructure	20,064.34	30,198.87	47.7
2	Internal and External Wall	11,751.15	17,401.16	27.5
3	Roof Structure and Covering	2,879.62	2,946.09	5
4	Doors and Windows	504.42	535.08	1
5	Wall Finishes	3,323.41	3,503.01	6
6	Floor Finishes	2,865.62	3,048.72	5
7	Ceiling Finishes	1,859.68	1,885.65	3
8	Painting and Decorations	1,713.46	2,053.26	3
9	Plumbing Installation	916.08	1,041.55	2
10	Electrical Instalations	***674.21***	730.56	1
	TOTAL	***46,551.98***	***63,343.96***	100

Source: Author's fieldwork

Emission from site Construction

The CO_2 emissions linked with site construction were computed by employing the emission coefficient of 2.7kg per liters of diesel, 0.0693 kg of CO_2 per liters of petrol, and 0.0733kg CO_2 per liters of Lubricant (World Resources Institute.WRI ,2012; Inter-governmental Panel on Climate Change-IPCC, 2006). Site investigation shows that 417.03 liters of diesel were used while 107.67 liters and 3.9 liters of petrol and lubricant were used respectively. The use of Diesel accounted for the highest site construction emissions with 99 % (1,125.98KgCO_2) (diesel combustion was used for on-site electricity generation, Bulldozers, and concrete mixer) while, petrol and lubricant accounted for 0.66% (7.46Kg CO_2) and 0.03 % (0.29 KgCO_2respectively). A total of 1,133.73Kg $CO_{2\ was}$ emitted per building during site construction of the reference buildings.

Transportation Emission

This is where emissions from mobile combustion are estimated by multiplying the total fuel used by the fuel emission coefficient (Equation 3). The emission coefficient used in the study is 2.712kg of CO_2 per liter of diesel. The volume of diesel expended for transportation of building materials was 1,884.72 liters. Thus, CO2 emissions from material transportation for the referenced building was estimated as 5,111.36KgCO_2

Carbon Emission from Building Maintenance (Recurring Emission)

The total liter of gasoline used to transport replacement materials was also determined and multiplied by 2.7 being the emission factor for Diesel. Using equation 6, the total recurring carbon emission was estimated at 31,131.38kg. This consists of 26,810.26kg from the material and 2,142.29kg from transportation.

3.2 Summary of Embodied CO_2eq Emissions

The total embodied carbon emission for the case study buildings was calculated by summing up the initial gate–to–site embodied carbon emission of materials, transportation, site construction, and carbon emission associated with maintenance as shown. The overall embodied emission was computed as 100,720.85KgCO_2.

Table 2: Summary of the Embodied Carbon Emission of the reference building

No	Emission Categories	Embodied Carbon Emission (KgCO_2)	Percentage (%)
1	Cradle-to-Gate	63,343.96	63
2	Transportation	5,111.36	5
3	Site Construction	1,133.73	1
4	Recurring Emission	31,131.38	31
	Total	100,720.85	100
	Intensity (MJ/m^2	484.23	

3.2 Sensitivity Analysis

The roof wooden eave fascia of the reference buildings was replaced with roof concrete eave fascia as currently being practiced in the study area especially with new buildings (see figure 4 and 5). According to ISO 14043 (1998b) sensitivity analysis is to assess the sensitivity of data elements that influence the results most greatly or the subject matter for the study. In this case, the subject matter is the roof eave facia. The result shows an increase in embodied emission with an average value of 4,551.34KgCO_2 (5.0%**)**. The sensitivity also highlights the relevance of concrete mix materials as sensitive materials that have vast quantities within buildings. They meaningfully influence and decrease the whole impacts, if designed carefully by architects.

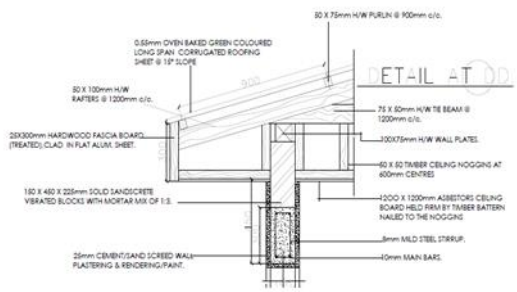

Figure 4; Details of Wooden Eave Fascia

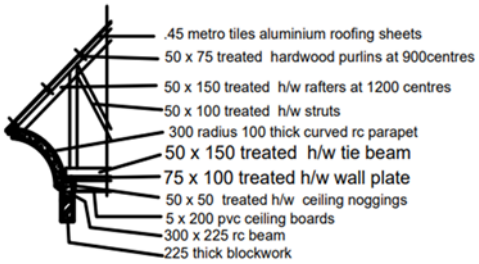

Figure 5; Details of Eave Fascia

4. CONCLUSION

The study revealed the environmental implication of the use of concrete eave fascia in residential buildings. The use of concrete eave fascia increases the concrete content/mix and hence the embodied carbon emission of residential buildings with 4,551.34KgCO_2 (5.0%**)**. These findings have raised environmental sustainability issues with the trend or current architectural practice in Nigeria. The values obtained from the study and existing Nigerian study show that the embodied emission intensity of the Nigerian housing sector is high. The implication is that while the world is moving towards zero carbon emission in the building sector as reported by the International Union of Architects (IUA), the Nigerian housing sector is experiencing an increase in the level of carbon emission intensity. Therefore, since the climate change mitigation strategy in residential buildings is aimed at eliminating or reducing carbon emissions the study suggests that the use of concrete eave facia should be discouraged if we are to be on the same page with other climes. Sustainable architecture is not a 'prescription', but it's an approach, practice, and attitude. The study reviewed the theoretical challenges associated with defining what we mean by calling a building "green" or sustainable architectural design and provides an insight into understanding the implications of the architect's decision with regards to climate change.

The imperative of an architect having an all-inclusive knowledge of all aspects of sustainability to be able to engage with a variety of professionals and specialists underscores the significance of this paper. Architects need to take responsibility at the early stage of building design by carrying out environmental sustainability assessments of their design. This is because no one can claim that his building design is sustainable until a Life Cycle Assessment is carried out. This calls for more enlightenment among architects in practice with regards to Life Cycle Carbon Assessment and the use of architectural design strategies for climate change mitigation and adaptations.

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SUB-THEME 4:

BUILDING COST MANAGEMENT

Influence of Supervision on Labour Productivity of Finishing Works in Ibadan, Oyo State

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Abstract:

There is the need for continued investigation into construction labour productivity because of its importance in the national economy of a nation. Insufficient training and oversight of construction skilled workers can be directly linked to low productivity. This study assessed the influence of supervision on labour productivity of finishing works in Ibadan, Oyo State. The objectives of the study were to: examine factors affecting effective supervision on construction site, compare the labour productivity of finishing works with supervision and those without supervision and determine the measures put in place by supervisors in ensuring effective labour productivity. The research employed a quantitative approach with the use of personal observation and survey questionnaire. Personal observation was made on 10 construction sites with professional supervision and another 10 site without professional supervision. The research data were collected with the aid of well-structured questionnaires. Also 50 questionnaires were administered to construction project contractors, project managers, supervisors and foremen of small and medium construction firms. The response rate of the questionnaires was 94%. Mean item score (MIS) and T-Test was used to rank the influence of supervision on labour productivity practice in construction workers on a 5-point Likert scale. It was found that the common factor affecting effective supervision on construction site is lack of adequate equipment (MIS = 3.98). It was also found that the key measure for ensuring effective labour productivity is commitment to work (MIS = 3.77) and that there was statistically significant difference between labour productivity of the site with supervision and those without supervision. This findings has led to the conclusion that those site with supervision generate more output than those without supervision with 8% differences. It is recommended that professionals should provide adequate equipment that suit in the work at hand, in order to achieved the organization goal and also improve construction site.

Keywords: supervision, labour, productivity, finishes work.

INTRODUCTION

A nation's construction industry plays a major role in any part of the world through the provision of infrastructures and buildings that support various social, economic and industrial functions (Isa *et al.*, 2014). Over the years, the contribution of the industry makes it a major factor in the drive for economic progress and development through the provision of infrastructures (Saurav *et al.*, 2018). In Nigeria, the industry when viewed from the perspective of its dynamism has the capacity to generate employment and absorb both skilled and unskilled operatives for the various trades in the sector (Peter *et al.*, 2014).

Construction is the world's largest industry. Nevertheless, the industry is faced with a numerous of problematical problems regarding poor productivity such as lack communication, inadequate participation, inadequate site visitation, and lack of commitment, inconsistent shared vision, misunderstandings, inadequate safety and insufficient quality of work (Jimoh *et al.*, 2017). Further lamented labour output signifies the quantity at what degree a single unit uses uncommitted resources to develop end product from stimulation. Thus, construction outputs fully rely on achievement of building artisan and as such decreased in labour output will really affect design value, duration and caliber.

In addition, many authors have studied the causes of failure in supervision on labour productivity. Construction projects executed all over the country are faced with numerous challenges such as low wages, lack of substantial and ungrateful working situation which have significant outcome on labour productivity (Ameh and Osegbo, 2011). Odusami *et al.* (2011) affirm that insufficient training and oversight of construction skilled workers can be directly linked to low productivity.

Jimoh *et al.* (2017) worked basically on foundation, block, wall, concrete, work, painting, plastering, but he didn't give a clear indication about finishing is just a mixed up, that leaves a knowledge gap that the study will fill by assessing the influence of supervision on labour productivity of finishing works with emphasis on site with adequate supervision practices and those without supervision. The research will assist the project managers, site engineers and construction team leaders in understanding the factors that enhance effective supervision on construction site.

LITERATURE REVIEW

Over the last few decades, the construction industry has made noticeable progress through advances in heavy equipment, tools, and materials (Goodrum *et al.*, 2009). The industry is one of the most important and significant sectors and supports the economic development of a country (Saurav *et al.,* 2018). As reported by Ade *et al.* (2013), the construction industry contributes to the economy, promotes growth, provides employment to the masses, and established a linkage between the economy and other industries.

Concept of Productivity in the Construction Industry

Productivity can be defined as the use of effective resources (inputs) in producing goods and or services (output) by Anu *et al.* (2014). Two measures of productivity are commonly used in the construction industry (Jarkas and Bitar, 2012). The first measure of productivity is the total factor productivity (TFP), which is defined as the ratio of total input to total output, with the latter usually including labour, materials, equipment, energy and capital. TFP is expressed as shown in Equation 1:

$$\text{TFP} = \frac{\text{Total Output}}{\sum(\text{Labour}+\text{Materail}+\text{Equipment}+\text{Energy}+\text{Capital})} \quad (1)$$

Barriers to improving labour productivity of Finishing Works

The country's economy has become increasingly more dynamic and complex (Peter *et al.,* 2014). As a result, economic measurement and analysis, particularly relating to productivity, have become more cumbersome and complicated (Adnan *et al.,* 2010). The main problem involves properly defining units of measurement, evaluating qualitative changes and obtaining reliable data for both inputs and outputs (Attar *et al.,* 2013). This process is further complicated by the need to price - deflate this data in order to evaluate changes in productivity in real terms. Measurement of inputs is problematic. Variations in the rate of input utilization are at best partially picked up in data series. In particular, the rate of capital equipment utilization, i.e. the measurement of machine hours, is rarely accomplished (Khaled *et al.,* 2011). Labour input, if measured by hours actually worked, is better suited to reflect the changing rate of manpower utilization, but remains an imperfect measure (Soham and Rajiv 2013).

Guidelines for improving the labour productivity of Finishing Works

The study of Attar *et al*. (2012) identified 14ways to improved labour productivity, namely: Proper training of the labourers, Motivation of workers towards project completion, Proper and in advance material procurement and management, On time payment to the workers, Systematic flow of work, Proper, clearly and in time supervision , Advance site layout, ,Maintain work discipline, Facilities to the labourers, Clearance of legal documents before starting of work, Systematic planning of funds in advance, Preman soon plan to avoid work stop, Maximum use of machinery and automation system, Advance equipment planning**.**

Supervision on Construction Site

Jimoh *et al.* (2017) defined supervision as a technique used to enhance developing the staff, and helps to equip the workers with the professional knowledge and skills necessary to do their job effectively, also gives the entire project team opportunity to communicate, coordinate, and cooperate within one another. Their study further lamented that supervisory works have become more complex and demanding, it requires professional and interpersonal skills. Supervision is the process of overseeing the ability of people to meet the goals of the organization in which they work (Salisu 2016).

Need for supervision on construction site

Construction productivity mostly depends on the performance of construction workers (Jergeas, 2009). However, most supervisory visits may be focused on inspection and fault-finding rather than providing workers the opportunity to improve their performance and solve problems during service delivery (Zimstat, 2014). The study of Zimstat (2014) revealed some reasons for effective performance and need of supervision as follow;

1. To ensure that specified standards are obtained throughout the work.
2. To ensure that works are completed within the estimated period.
3. To ensure that operators put honesty and faithfulness in their output.
4. A construction supervisor assures that the goals of the program are implemented and completed.
5. A construction Supervisor works diligently, on behalf of prospective and established project owners.

Supervision and productivity improvement

One way that construction supervisors can improve productivity is by determining how to influence worker's attitude, how smooth the work will flow and how much work can be accomplished (Abd-el-hamied, 2014). A good leadership and supervision in construction projects increased the productivity through decreasing production costs, reducing time required for the operation, improving profit, improving the quality of product and increasing the utilization of resources (Aberey *et al.,* 2014). Abd-el-hamied (2014) stated that the cycle for productivity improvement involves four phases: productivity measurement, evaluation, planning and improvement.

Factors Affecting Effective Supervision on Construction Site

A study conducted by Brent and Leighton (2014) established 10 most significant factors affecting construction productivity and they include; lack of materials, incomplete drawings, incompetent supervisors, lack of tools and equipment, absenteeism, poor communication, instruction time, poor site layout, inspection delay and rework. Earlier, Dozzi and AbouRizk (1993) as cited by Benviolent *et al*. (2014) stated that the factors undermining the supervision of construction workers are; construction type, scope, layout and complexity, construction methods, weather, skill of the work force, work practice, length of work day, availability of materials, incentives, degree of supervision, enabling environment, government regulations and organization size.

Attar *et al*. (2013) identified factors that affects construction productivity, and categorized them into 8 factors of internal and external. The internal constraints with five groups of factors include; project characteristics, project finance, workforce, project management and technology process. While the external constraint with three groups of factor are unforeseen

events, statutory compliance and other external forces. According to Saurav *et al.* (2018), factors affecting construction supervision on labour productivity can be grouped into 15 categories according to their characteristics, namely; design factors, execution plan factors, material factors, equipment factors, labour factors, health and safety factors, supervision factors, working time factors project factors, quality factors, financial factors, leadership and coordination factors, organization factors, owner consultant factors and external factors.

1. Comparison of Labour Productivity of finishing works with Supervision and those without Supervision

According to Saurav *et al.* (2018), productivity of projects is measured by rewarding, controlling and monitoring the performance, and to do the benchmarking to set the firm's future strategy that to be aligned to the basic objective of enhancing profit through supervision. The success of any project is repeatable and it is possible to find out a set of certain success attributes for the success of a construction project and it requires a controlled discipline hardworking supervision (Mendal *et al.,* 2018).

Construction site supervision is a crucial element. The inability of many supervisors to plan the work, communicate with workers, and direct activities adequately is fundamentally linked to increasing amount and cost of rework and other quality issues (Olagunju *et al.,* 2013). Site without supervision results in defective building construction which not only contributes to the final cost of the product but also to the cost of maintenance, which can be substantial (Adamu *et al.,* 2011). It was further revealed that defective construction may lead to the complete failure of a structure.

Completing projects in a predictable manner of time (within schedule) is one of the important indicators of supervision on project success (Shahab *et al.*, 2018). Ghoddousi and Hosseini (2012) revealed that accurate scheduling can be achieved by hiring experienced personnel to supervise the work, to do planning, and using the historical data of similar projects to make an accurate estimation of the required time for each activity. Organizational success is dependent upon members being supervise or motivated to use their full talents and abilities, and directed to perform well in the right areas (Osabiya, 2015).

2. Measures for Ensuring Effective Labour Productivity

Supervisors encourage workers to adopt good practices in order to achieve a high level of performance and such 'supportive' supervision is significant and more beneficial to productivity of construction workers (Jimoh *et al.,* 2017). The benefits of supervision on construction workers using limited resources remain uncertain, even though the quality of supervision may be a key determinant of its impact on productivity (Merrow *et al.,* 2009). Fischer (2009) concluded that the impact of management styles and techniques on workers' productivity is significant through exercising power that leaders (supervisors) are able to influence others, this power can lead to one of the following reactions; commitment, compliance or resistance which affects productivity.

Supervisors may influence productivity through their decisions after their study and observation for the productivity measurement and evaluation. Fischer (2009) implied that effective delegation of responsibilities and management of required number of workers by the supervisors will give better performance and increase in productivity. Frimpong *et al*. (2011) stressed that supervision increases worker's empowerment, time management, fewer complaints and more positive feedback. A study carried by Chigara and Moro (2014) listed four categorized ways to improve labour productivity through management practices. These

strategies include; planning, resource supply and control, supply of information and feedback, and selection of the right people to control certain factors. Nevertheless, labor productivity still needs improvements.

According to Osabiya, (2015), suggested that different types of reward practice may more closely complement different generic strategies and are significantly related to higher levels of perceived labour output. With a positive motivation philosophy and practice in place, productivity, quality and service should improve because motivation helps people towards achieving goals, gaining positive perspective, creating the power for change, building self-esteem and capability, and managing their development and helping others (Moselhi 2010).

RESEARCH METHODOLOGY

This research will basically employ the use of survey design method using the quantitative approach through a well-structured questionnaire to assess the influence of supervision on labour productivity of finishing works in Ibadan, Oyo State. The research employed a quantitative approach with the use of personal observation and survey questionnaire. Personal observation was made on 10 construction sites with professional supervision and another 10 site without professional supervision. The research data were collected with the aid of well-structured questionnaires. Also 50 questionnaires were administered to construction project contractors, project managers, supervisors and foremen of small and medium construction firms. The response rate of the questionnaires was 94%. The structured questionnaires employed to gather information for the study was designed using the five-point Likert Scale format. MIS and T-TEST were employed to analyse the data collected in order to achieve the research objectives. The use of MIS for the analysis of data in this study is based on the formula.

$$\text{MIS} = \frac{\Sigma W}{N} \qquad (2)$$

Where: Σ = Summation of the weight, W= Population x scaling factor (5, 4, 3, 2, 1) and N = Total number of respondents that professionals questionnaire was administered.

DECISION RULE TABLE

The decision rule employed for the T-TEST and MIS analysis is summarized in Table 1

Scale	Interpretation					
	MIS	t-test	Frequency of Occurrence	Level of Importance	Level of Significance	Level of Effectiveness
5	4.51- 5.00	If p value < 0.05; difference is significant. But if p value > 0.05; difference is not significant.	Very often	Very Important	Very Significant	Very Effective
4	3.51 - 4.50		often	Important	Significant	Effective
3	2.51 - 3.50		Fairly often	Fairly Important	Fairly Significant	Fairly Effective
2	1.51 – 2.0		Less ;ften	Less Important	Less Significant	Less Effective
1	1.00- 1.50		Rarely	Least Important	Least Significant	Least Effective

RESULTS AND DISCUSSION

Results on Factors Affecting Effective Supervision on Construction Site

This section presents and discusses the MIS results of the factors affecting effective supervision on construction site, which 24 factors were identified. The MIS results are presented in Table 2.

Table 2: MIS Ranking on Factors Affecting effective supervision on construction site

S/No.	Factors Affecting Effective Supervision on Construction Site	MIS	Rank	Decision
1	Lack of adequate equipment	3.98	1ST	High
2	Construction training	3.32	2nd	Neutral
3	layout and complexity	3.30	2nd	Neutral
4	Technology	3.09	4th	Neutral
5	Change of labour and staff wages	3.40	5th	Neutral
6	Weather condition	3. 04	5th	Neutral
7	Inspection delay and rework	2.89	7th	Neutral
8	Construction type	2.89	7th	Neutral
9	Availability of materials	2.87	9th	Neutral
10	Skill of the work force	2.85	1oth	Neutral
11	Instruction time	2.82	11th	Neutral
12	Incompetent supervisors	2.79	12th	Neutral
13	Work practice	2.77	13th	Neutral
14	Lack of material	2.70	14th	Neutral
15	Absenteeism	2.64	15th	Neutral
16	Poor site layout	2.64	15th	Neutral
17	Length of work day	2.60	17th	Neutral
18	Incentives	2.57	18th	Neutral
19	Project uniqueness	2.55	19th	Neutral
20	Poor communication	2.51	2oth	Neutral
21	Enabling environment	2.47	21st	Low
22	Degree of supervision	2.47	21nd	Low
23	Compliances with government regulation and organization size	2.45	23rd	Low
24	Incomplete drawing	2.36	24th	Low

Source: Data analysis (2019)

It was revealed that the most commonly adopted factor for effective supervision on construction site is Lack of adequate equipment" with of MIS=3.98. The 2nd ranked is "Construction training" with MIS=3.32. The 3rd ranked is'' layout and complexity" with MIS= 3.30. The least two ranked factor affecting effective supervision construction site are Compliance with government regulation and organisation sizes" with MIS=2.45, and "Incomplete drawing" with MIS=2.36). The result is in line with Brent and Leighton (2014) findings that some factors must be considered by construction manager in order to achieve project objectives. Some of these factors include the following: project uniqueness, technology, management, labour organization, real wage trends, and construction training.

Results on Measures for ensuring effective labour productivity

This section examines the measures for ensuring effective labour productivity. These was ranked using MIS in order of importance. Tables 3 give summaries of the results of measures for ensuring effective labour productivity.

It was revealed that the commonly adopted measures for ensuring effective labour productivity. Commitment to work" with of MIS=3.77, The 2nd ranked is "Selection of the right people to control certain factors" with MIS=3.13, the next 3rd ranked is'' Proper management of tools, equipment, and minerals" with MIS= 3.30, and The least two ranked measures for ensuring effective labour productivity are Adequate supervision" with MIS=1.79, and "Resources supply and control" with MIS=1.74).

The result is in line with Fischer (2009) findings that stated that some measures must be considered by construction manager in order to achieve project objectives, such as impact of management styles and techniques on workers' productivity is significant through exercising

power that leaders (supervisors) are able to influence others, this power can lead to one of the following reactions; commitment, compliance or resistance which affects productivity.

Table 3: MIS Ranking on measures for ensuring effective labour productivity

S/N	Measures put in places for effective labour productivity	Mean	Rank	Decision
1	Commitment to work	3.77	1ST	High
2	Selection of the right people to control certain factors	3.47	2nd	Neutral
3	Proper management of tools, equipment, and minerals	3.13	3rd	Neutral
4	Planning	2.87	4th	Neutral
5	Fewer complaints and more positive feedback	2.45	5th	Low
6	Encouragement of workers by the supervisors	2.45	5th	Low
7	Management styles and techniques on workers production	2.21	7th	Low
8	Positive motivation philosophy and practice in place	2.oo	8th	Low
9	Compliance with supervisor instruction	1.98	9th	Low
10	Effective delegation of supervisors	1.98	9th	Low
11	The relative efficiency of labour doing what it is required to do at a given time and place	1.85	11th	Low
12	Time management	1.83	12th	Low
13	Supply of information and feedback	1.81	13th	Low
14	Adequate supervision	1.79	14th	Low
15	Resources supply and control	1.74	15th	Low

Source: Researcher' Analysis (2019)

Results on Site Observations and Measurements

Test of difference between Productivity with professional supervision and without professional supervision

Table 4. Shows the result of the t-test analysis performed to compare the difference between productivity with professional supervision and without professional supervision. It was apparent from the analysis that the value of t-calculated (0.098) was less than the value of t-tabulated (1.81); and the probability value (0.020) was lower than 0.05 (5%) level of significance and within 95% confidence level. The evidence is statistically significant. The result implies that there is statistically significant difference between the site with supervision and those without supervision

Table 4: Test of difference between Productivity with professional supervision and without professional supervision

S/n	Variables		Type of analysis	Observation			Inference	
	X1	X2		T-cal	T-tab	P value	Remark	
1	Productivity with Professional Supervision	Productivity without Professional Supervision	T-test	1.148	1.81	0.098	There was statistically Significant between **X1** and **X2**	

Source: Researcher's Field work, 2019

CONCLUSION

Labour is a key resource on building projects and effective management of the resource to achieve optimal productivity cannot be over emphasized. This study has brought into focus on influence of supervision on labour productivity on finishing works. After a series of extensive literature review and findings, the result brought forth the following conclusions:

Lack of adequate equipment is the most important factor leading to effective supervision on construction sites, therefore adequate equipment should always be provided in order to improve construction on site. Commitment is the most measures put in place by supervisors in ensuring effective labour productivity, therefore all professionals should be fully committed to each activities he/she engaged. The research also found that there was statistically significant difference between labour productivity of the site with supervision and those without supervision. This shows that those site with supervision generate more output than those without supervision with 8% differences.

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Analysis of Stakeholder Management of Construction Project in Abuja, Nigeria

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Abstract:
The structure of the Nigerian construction industry is very complex in nature and consists of a wide range of parties. The aim of this paper is to analyse stakeholder management in construction projects in Abuja, with the view to improve construction projects performance. This study identifies and assesses barriers to stakeholder management in construction projects and determines critical success factors influencing stakeholder management and the delivery of construction projects. The paper employed a qualitative research design approach through semi- structured interviews. 30 construction professionals interviewed were purposively selected based on their experience. Content analysis was used to analyse information gotten from them. The study identified 25 barriers affecting stakeholder management and 14 critical factors influencing successful stakeholder management through interview carried out. The factors and barriers frequency mentioned during the interview were ranked. "Poor knowledge of stakeholder management procedure" and "lack of proper stakeholder management procedures" were the highest mentioned barriers affecting stakeholder management. Effective Communication emerged the highest ranked critical factor for successful stakeholder management. The study concluded that there is need to pay special attention to the above barriers and recommends appropriate strategies one of which is appropriate stakeholder analysis and engagement process within consulting project management firms managing project stakeholders.

Keywords*: Construction; stakeholder management; project delivery, qualitative approach.*

INTRODUCTION

The construction sector is very crucial to every nation's social and economic development. Apart from the sector's potential of employment generation, various activities undertaken in the sector are very germane to fostering effective linkages and enhancing as well as sustaining economic development. (Adeagbo, 2014). The Nigerian's construction industry like in other countries is very complex in nature, consists of building, civil and heavy engineering construction works which can be executed under different types procurement systems. The industry consists of a wide range of different parties such as main contractors and sub-contractors and clients which may be either public or private. The industry activities are been carried out on a project basis and could be within an organization or part of a construction programme (Adamu & Kolawole, 2011). Each project is unique in nature, while the project success or performance is measured based on criteria such as time, cost and quality (Project Management Institute, 2017). The success or failure of any project is based on the interests of the stakeholders directly or in-directly involved in the project (Atkinson, 1999). Studies Poor performance is the major challenge confronting the industry. Association for Project Management (APM) considered stakeholder management as the systematic identification, analysis, planning and implementation of actions designed to engage with stakeholders. Stakeholders include project team members as well as other interested entities and they can be categorised into internal and external stakeholder based on their level of involvement in the project life cycle. External stakeholders can be exemplified as customers, suppliers and related state mechanisms, while internal stakeholders are the project managers, project team and project sponsors (Project Management Institute, 2017). The categorisations show competing expectations that may lead to conflicts within the project. Apart from that, stakeholders also exert influence on the project, its deliverables, and the project team in order to achieve a set of outcomes in order to satisfy strategic business objectives or other needs (Dagli, 2018).

Ajayi *et al*. (2010) attributed disagreement among participating parties as one of the reasons for project failure in Nigeria. The conflicts associated with the industry are as a result of its

complex nature, size of the industry and the challenges of satisfying its customers. Onarinde (2011) pointed out that the Nigerian Construction Industry has not fully reaped the benefits of managing stakeholders in projects. In Nigeria, carrying out a planning for a project is not a guarantee of project success. Several projects still fail when stakeholders were not properly managed. According to Abdu- Lawan (2016) projects were suspended for quite a long time due to unresolved disputes between two major stakeholders involved in the project. Disputes on the projects are the reflection that some stakeholders still lack the knowledge of critical factor for stakeholder management and barriers to stakeholder management. The performance of the stakeholders is affected by the conflict and dispute on the project. To achieve project objectives, it is important to investigate barriers and critical factors having positive influence on the stakeholder's successful project delivery

This paper aimed at analysing stakeholder management(SM) in construction projects in Abuja, Nigeria, with the view to improve on construction projects performance. The following objectives were adopted to achieve this aim:

- To examine the barriers to stakeholder management.
- To investigate critical factors having influence on the stakeholders management successful delivery of construction projects.

LITERATURE REVIEW

Stakeholder management greatly contributed to the successful project outcomes (El-Naway, Mahdi, Badwy and Al-Deen, 2015). The success of construction projects dependent on the ability to manage various individuals and entities having stakes on the project. El Sawalhi (2015) asserted that stakeholders can be divided in two categories, namely internal and external. El Sawalhi (2015) opined that the internal stakeholders include employees, board members, company owners, donors and volunteers. The implication of this classification is that anyone who contributes to the company's internal functions can be considered an internal stakeholder. On the other hand, external stakeholders include customers, public authorities, clients, local communities, business partners, suppliers and shareholders. Anyone who is affected by your company but who does not contribute to internal operations is an external stakeholder. Stakeholder Management (SM) plays a very vital role in project performance in complex projects (Beringer *et al*., 2012). SM does not just focus on single stakeholders, but accounts for all stakeholders' influence on one another in complex interactions of multiple, and potentially interdependent stakeholders (Beringer *et al*., 2012).

Various studies have made substantial efforts to shed light on the concept of engaging and managing stakeholders in projects that are observed as multifaceted. Williams *et al*. (2015) observed the network structure of online stakeholders' discussions in the planning stage of a mega project that was highly complex because it was embedded in a network of stakeholders who were either supporting or opposing the project. Aaltonen *et al*. (2015) sought to advance understandings of stakeholder challenges in complex projects by focusing on the planning phase. Aaltonen *et al*. (2015) analysed how stakeholder dynamics—including stakeholder influence strategies, SM strategies and project contextual conditions—are affected by the interactions between stakeholders' influence, SM activities and the project's contextual conditions. Mok *et al*. (2015) conducted a literature review on SM studies that focused only on mega construction projects, and stated that traditional stakeholder analysis techniques are widely adopted in mega construction projects notwithstanding their weaknesses; moreover a social network approach for managing interrelationships in these projects is needed.

Eskerod *et al*. (2015) examined project SM by considering a theory outside the project management field to advance understandings of this topic. However, they emphasised the core

argument that the current working forms are not suited to address the increased complexity facing project managers and project teams. In addition, it is widely recognized in the literature that many projects ultimately fail (Damoah and Akwei, 2017; Sharma *et al*., 2011). Although the causes of failure may be as a result of project complexity which make it difficulty in completing projects and requires extra effort to overcome (Dao *et al*., 2016). Complex projects demand systematic approaches and efficient management skills to manage stakeholders to attain the best outcomes in terms of project performance (Mok *et al*., 2015).

Barriers to Stakeholder Management

According to Newcombe (2003), stakeholders interact with the project in two fronts: cultural and political. These two fronts combined to impose invaluable barriers on stakeholder's engagement process. Barriers can emanate from the lack of awareness within the external stakeholders community in respect of available package thereby resulting in exclusion of citizens (Ihugba & Osuji, 2011). Under-resource or insufficient allocation of time and resources can result in sub-optimal outcome, strong resistance either from the stakeholders or construction organisations towards engagement (Olander & Landin, 2008). The lack of identifiable project leadership also generates lack of accountability and transparency in the process. This may eschew difficulty in establishing legitimacy (Beaumont & Loopmans, 2008). Zarewa (2019) explored some factors identified by various scholars as follows:

Abdu Lawan (2016) identified : Cultural diversities(language barriers), lack of corporation from Stakeholders, client's behaviour, disagreement amongst stakeholders, absence of well-organised stakeholder meetings, handing over similar tasks to more than one stakeholder. TeyeBuertey *et al.* (2016) identified: Stakeholders' inability to participate in discussions, Lack of stakeholder involvement, Stakeholders lack of capacities to contribute meaningfully in discussions, Non acknowledgement of value of stakeholders, Non determination of requirements and expectations of stakeholders and inadequate identification and engagement of all stakeholders. Blood (2013) identifies compartmentalisation, lack of baseline data, cumulative effect of incremental development, stakeholders' fatigue, gap between public expectation and regulatory requirements as imminent problems inducing ineffective stakeholders' engagement in mining projects. From these broad themes, the study identifies organisational, project environment, communication, contractual, and regulatory issues affecting stakeholder management.

Bal *et al.* (2013) asserted that performance and economic contribution of a project is increased when effective stakeholder management and engagement process is carried out. Ihugba and Osuji (2011) stated that barriers on the part of external stakeholders' community arise from lack of awareness. Paying attention to the long term objectives of projects at the detriment of the short term objectives of community stakeholders can also breed public resistance (Olander and Landin, 2008).

Critical Factors Influencing Stakeholder Management Successful Delivery of Construction Projects

Projects that involve all the necessary stakeholders are far more likely to be successful (Zucker, 2017). According to Magassouba *et. al* (2019) stakeholder involvement in project identification, planning, implementation and monitoring enhances the chance of project success and it is an appropriate way to achieve an organization's goals. Project success refers to the effectiveness of a project and focuses on the multiple stakeholders involved as well as the ultimate results, or project benefits (Hidding and Nicholas 2014). Critical success factors are those activities and practices that should be addressed in order to ensure successful management of stakeholders in construction project (Forsman, 2017). Yang *et al.* (2009) defined CSFs in terms of stakeholders' management as "those activities and practices that

should be addressed in order to balance stakeholders' interests and further ensure that projects are moved forward". Yang *et al*. (2009) studied major critical success factors and ranked the top three: 1. managing stakeholders with social responsibilities, 2. Exploring the stakeholder needs and constraints to the project 3. Communicating with and engaging stakeholders with social responsibilities. Ogwuleka (2013) recommends objective management and managing the process of design as critical success factors. Ihuah *et al*. (2014) identifies a competent project team as the most relevant critical success factor. Tung (2014) inferred that engaging and promoting good relationship and formulating clear statement of project missions as significant factors. Molwus (2014) hypothesised that adequately obtaining information on stakeholder characteristics and project characteristics, carrying out informed stakeholder analysis, understanding stakeholder dynamics and effective stakeholder engagement affect the impact of stakeholder management on construction project success. Forsman (2017) indicates that engaging stakeholders properly, understanding areas of stakeholders' interest and predicting the influence of stakeholders accurately in order to seek their support for the project as major influences in project success and performance.

RESEARCH METHODOLOGY

The study investigates influence of stakeholder management on construction projects delivery in Abuja. In order to achieve the aim and the objectives of this study, a qualitative research approach is considered appropriate. A semi-structured interview was used to collect primary data from selected construction practitioners within Abuja to analyse barriers to stakeholder management and to investigate the factors influencing stakeholder management successful delivery of projects.

For an in-depth understanding of those two items face to face interviews was conducted. A list of pre-determined questions was prepared based literature on the barriers and CSFs of SM. Detailed answers were obtained as the method allowed the respondent to expatiate on the topic. The interview questions are semi-structured which helped to limit the boundary of discussion while allowing transparency and provided a better understanding of the responses. The interview consists of a total of 17 questions ranging from personal information to knowledge on stakeholder management practices. Thirty respondents were purposively selected based on their experience and roles played in the management of the projects. 30 professionals in the construction industry were interviewed comprises of 18 quantity surveyors, 7 Architects, 3 Civil Engineers and 2 project managers.

Content analysis was used to analyse the information gotten from the interviewees after coding and put together results.

RESULTS AND DISCUSSION

The vast majority of respondents were quantity surveyors, with 60% and 23.3% were architects, 10% civil engineers and 6.7 % project managers. All the respondents have over five years' experience in the industry, with 4 of the architects, 2 of the civil engineers and 10 of the quantity surveyors having over 10 years' experience in the industry. This can be attributed to the fact that it takes a significant number of years to gain enough experience and a good reputation which would enable one to do consulting or undertake challenging projects. According to the academic qualification 2 of the architects had bachelor's degrees while the other 5 had masters degrees, all of the civil engineers had bachelor degrees, one of project managers had bachelor's degrees while the other one had masters degrees, 10 of quantity surveyors have master's degrees while the remaining 8 have bachelor's degrees.

The breakdown is as follows: 18 quantity surveyors (QS1-18), 7 Architects (AR1-7), 3 civil engineers (CE1-3), 2 Project Managers (PM 1-2).

Table 1. Interviewee's Responses to Barriers of Stakeholder Management and Critical Success Factors of Stakeholder Management

SN	Interviewee code	designation	Barriers mentioned	Critical Success Factors Mentioned
1	QS1	Quantity surveyor	1. Delay in payment 2. Lack of proper stakeholder management procedure 3. partial stakeholder involvement	Project coordination
2	QS2	Quantity surveyor	1. Misinterpretation of stakeholder participations 2. Variation in contract form	Proper Engagement of stakeholders
3	QS3	Quantity surveyor	1. False and incorrect information given to stakeholders 2. Lack of consequent stakeholders' meetings.	Assessing strengths and weaknesses of stakeholders
4	QS4	Quantity surveyor	1. Lack of Human resources training 2. Lack of corporation from client	Proper Engagement of stakeholders
5	QS5	Quantity surveyor	1. Time constraints 2. Inconsistency in allocating stakeholder roles(Swapping roles within stakeholders)	Proper Engagement of stakeholders
6	QS6	Quantity surveyor	1. Lack of proper conflict resolution techniques 2. Lack of proper stakeholder management procedure 3. Lack of corporation from client	Understanding and working with stakeholders' needs
7	QS7	Quantity surveyor	1. Additional works 2. Lack of proper stakeholder management procedure	Proper identification of stakeholder roles
8	QS8	Quantity surveyor	1. Lack of proper stakeholder management procedure 2. Disagreements amongst stakeholders	Project coordination
9	QS9	Quantity surveyor	1. Poor knowledge of stakeholder management 2. False and incorrect information given to stakeholders	A competent Project team
10	QS10	Quantity surveyor	1. Misinterpretation of stakeholder participations 2. Unqualified personnel tasked with the role of stakeholder management	Clear definition of project mission
11	QS11	Quantity surveyor	1. Lack of proper conflict resolution techniques 2. Lack of corporation within stakeholders	Effective communication
12	QS12	Quantity surveyor	1. Unqualified personnel tasked with the role of stakeholder management 2. Poor knowledge of stakeholder management	Assessing strengths and weaknesses of stakeholders
13	QS13	Quantity surveyor	1. Unqualified personnel tasked with the role of stakeholder 2. Delay in payment	Understanding and working with stakeholders' needs
14	QS14	Quantity surveyor	1. Location of construction project 2. Clients interfering with stakeholder management process	Promoting good relationship
15	QS15	Quantity surveyor	1. Unfair treatment of stakeholders 2. Cultural differences 3. Corruption	Clear definition of construction ethics
16	QS16	Quantity surveyor	1. Cultural differences 2. Poor knowledge of stakeholder management	Proper identification of stakeholder roles
17	QS17	Quantity surveyor	1. Lack of consequent stakeholders' meeting	Effective communication

			2.	Inconsistency in role allocation(swapping roles within stakeholders)	
			3.	Too many stakeholders claiming seniority	
18	QS18	Quantity surveyor	1.	Poor knowledge of stakeholder management	Project coordination
19	AR1	Architect	1.	False and incorrect information given to stakeholders	Proper identification of stakeholder roles
			2.	Lack of corporation within stakeholders	
			3.	Corruption	
20	AR2	Architect	1.	Lack of Human resources training	Understanding and working with stakeholders' needs
			2.	Corruption	
			3.	Time constraints	
21	AR3	Architect	1.	preferential treatment amongst stakeholders	Proper Allocation of stakeholder roles
			2.	Lack of corporation within stakeholders	
22	AR4	Architect	1.	Disagreements amongst stakeholders	Understanding and working with stakeholders' needs
			2.	partial stakeholder involvement	
			3.	Too many stakeholders claiming seniority	
23	AR5	Architect	1.	Too many stakeholders involved in same project	Effective communication
			2.	Too many stakeholders claiming seniority	
24	AR6	Architect	1.	Unfair treatment of stakeholders	Abiding to construction ethics
			2.	Too many stakeholders involved in same project	
25	AR7	Architect	1.	Lack of proper stakeholder management procedure	Proper identification of stakeholder roles
			2.	Poor knowledge of stakeholder management	
			3.	Location of construction project	
26	CE1	Civil Engineer	1.	False and incorrect information given to stakeholders	Effective Communication
27	CE2	Civil Engineer	1.	Lack of consequent stakeholders' meeting	Supportive attitude towards stakeholders
28	CE3	Civil Engineer	1.	Lack of consequent stakeholders' meeting	Analysing conflicts amongst stakeholders
			2.	Additional works	
29	PM1	Project Manager	1.	Too many stakeholders claiming seniority	Effective communication
			2.	partial stakeholder involvement	
			3.	Cultural differences	
30	PM2	Project Manager	1.	Lack of corporation within stakeholders	Effective communication
			2.	Lack of corporation from client	

Table 1 shows that *lack of proper stakeholder management procedure* is highly mentioned barrier to stakeholder management and *Poor knowledge of stakeholder management*. 5 out of the 30 interviewees mentioned these two factors hindering the successful stakeholder management. Second highest was *lack of consequent stakeholders' meeting, false and incorrect information given to stakeholders, lack if corporation within stakeholders,* and *too many stakeholders claiming seniority* having 4 out if 30 interviewees mentioning them. While the 3rd in line were *corruption, cultural differences, lack of corporation from clients, unqualified personnel tasked with SM* and *partial involvement of stakeholders* with mentions from 3 interviewees each. In 4th position is *delay of payment, unfair treatment of stakeholders, additional works, time constraints, location of construction project, lack of proper HR training,*

inconsistency in role allocation, misinterpretation of stakeholder participation, disagreements amongst stakeholders, too many stakeholders involved in managing same project and *lack of proper conflict resolution techniques* all having 2 mentions each. The 5th in line were *Variation, preferential treatment within stakeholders* and *clients interfering with SM process* with only 1 mention each.

Lack of proper stakeholder management procedures -Most of the respondents that spoke about this talked about SM procedures like stakeholder identification and stakeholder engagement. One of the architects that was interviewed went ahead to mention lack of proper stakeholder analysing and monitoring as hindrances. The interviewees, nonetheless, established that inappropriate stakeholder identification, engagement and analysis affects SM process by having to reassess, review and reassign interests, roles and responsibilities. Also, they were of the opinion that depending on the strategic approach taken towards stakeholder management, the process can be very smooth and properly executed. Taylor (2015) described stakeholder engagement as gathering and sharing information, dealing with concerns and grievances from stakeholders, measuring their impact and importance, communicating back and forth through various methods, and more, clearly highlighted its importance to achieving ESM. To ensure a successful project, project team must identify and engage all stakeholders, observed that most projects fail after implementation not due to poor execution but rather due poor stakeholder consultation and engagement (TeyeBuertey *et al*. (2016).

Poor knowledge of stakeholder management-Five interviewees also mentioned poor knowledge of SM as a major barrier for effective SM. Interviewees asserted that SM process cannot be improved if the project manager does not understand, cannot successfully carry it out or is not ready to embrace it. One of the quantity surveyors emphasized "*It is not possible to do what you don't know how to do! It's really simple; you can't successfully practice what you don't have expertise in*". Other interviewees were of the position that it is very important that construction professionals like architects, quantity surveyors and civil engineers that practice project management must have undergone efficient, in-depth and proper training in order to carry out the job effectively. Because carrying out the process of SM without adequate knowledge may serve as a roadblock to the process thereby obstructing the success of the project. The respondents agreed that lack of knowledge of SM affects project organization, project development, causes setbacks, may have legal implications and has consequences on the entire SM process. EyiahBotwe1 *et al* (2015) identified PMs' poor knowledge as a major Critical Barrier Factor for an effective SM. Zarewa(2019) postulates that Project Manager's poor knowledge of SM, has direct relation with quality of SM in any project delivery because a project manager cannot effectively manage stakeholders without appropriate knowledge and skills.

Furthermore, each interviewee was asked to state in their experience and opinion what the most effective and important critical success factors to SM were. Each of them mentioned one critical success factor. *Effective communication* was the most mentioned with 6 out of 30 interviewees. Ranking second were *proper identification of stakeholders* and *understanding and working with stakeholders' need* with 4 mentions each.

Ensuring Effective Communication-This factor ranks highest amongst the CSFs determined, most of the interviewees agreed that it is important for communication to be effective, real, consistent and strategically executed. One of the project managers cited an example of a project he worked on that had a steady communication plan that was efficiently abided by and insisted "*that was one of the reasons things went smoothly in that particular project*". Another project manager stated that "there is need for mutual respect amongst workers and clients in order to effect good and useful communication" .Peter (2017) asserted that continuous consultation and

open communication with all stakeholders and groups is one of the steps to ensure that stakeholder groups and individuals are effectively managed and engaged within project.
This is an extremely crucial success factor as communication is vital for upholding the obligation of all stakeholders. According to Eric *et al.* (2014), project managers should be highly skilled negotiators and communicators capable of managing individual stakeholder's expectations and creating a positive culture change within the overall organization. Bourne (2010) further postulates that effective planning and implementing the right specific communication strategy for each of the project stakeholder(s) is considered as one of the most important role the project manager often time consuming.
Proper Identification of Stakeholders-Another CSF the interviewees agreed upon is the need to ensure proper identification of stakeholders. One of the quantity surveyors stated that "*the main question to look into is- who are the stakeholders? How are they classified? Then we can talk about stakeholder management*." It is very necessary to properly identify stakeholders. Another quantity surveyor relates that carefully identifying and listing the project stakeholders before the commencement of project is highly important. A conceptual scheme for identifying stakeholders should have recognition for a player's power to influence the legitimacy of relationship between players, and the urgency of a stakeholder's claim such that a detailed identification of project stakeholders is achieved (Jepsen and Eskerod, 2009).

CONCLUSION

Through qualitative research conducted after extensive literature review of related work, this paper revealed the perception of the stakeholders on effective stakeholders' management in construction project delivery This study revealed that there are eminent barriers that need to be tackled in order to ensure smooth engagement of stakeholders in construction project. The barriers majorly mentioned and deduced from the interview analysis in this study were:
1. Lack of proper stakeholder management procedures.
2. Poor knowledge of stakeholder management and
3. False and incorrect information given to stakeholders.

The study also investigated critical success factors influencing SM through interviews, the CSFs which ranked the highest were:
1. Effective communication
2. Understanding and working with stakeholders' needs and
3. Proper identification of stakeholders.

In the face of the awareness and reactions of the significance of effective stakeholder management, the survey however revealed that there is still no entire apposite acceptance of the procedures for stakeholder management as earlier postulated in literature. Thus recommends that:
1. The requirement to analyse stakeholders should be accentuated by clients in Nigeria and the procedure should be steady and constant and should be included in all phases of construction.
2. Appropriate stakeholder analysis and engagement process should be incorporated by consulting project management firms in managing project stakeholders.
3. Clients should insist on continuous stakeholder engagement.
4. Every project should have well-trained and qualified professionals handling project management.
5. The project managers should create proper engagement and communication systems to ensure proper operations.
6. Other construction professionals carrying out project management roles should be well trained in the process.

7. Strategic communication should be appropriately maintained within the stakeholders and information and updates should be properly passed across as there should be an adequate communication chain for decisions, suggestions and complaints

It is nonetheless imperative to note that the study has some limitations that may affect oversimplification of its findings. One of such limitations was the restriction of the study to a selected location in Nigeria (Abuja). Secondly, the study was qualitatively conducted which limit its generalisation. Findings of the study could still be used to conduct another study in wider locations using similar or different research method.

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Factors Influencing Building Materials Price Fluctuation in Abuja, Nigeria

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Abstract:

The rate of fluctuation claims by contractors on materials prices is alarming. This leads to disputes in most building projects and usually affects the cost, time and even quality performance of building projects. The study examined the factors responsible for material price fluctuations in building construction projects and determines the impact of materials price fluctuation claims on cost performance with view to minimising the resultant effects on contractors. The study adopted a survey design approach using quantitative data. Data were collected through well-structured questionnaire administered to 250 respondents; also archival data on cost of material price fluctuation claims on completed building projects in the study area were obtained. A total of 170 questionnaires were retrieved from 250 distributed along with 23 archival data. The collected data were analysed using percentages, Relative Importance Index (RII) and Pearson Correlation Moment. Result reveals that the major factors responsible for building material price fluctuation are; exchange rate of national currency, cost of transportation, inflation of building materials and cost of energy. The results further indicate that materials price fluctuation claim has a direct correlation with total project cost with a significant level (p value) of 0.01. It is recommended that drastic steps should be taken by Government to stabilise naira exchange rate, reduce cost of energy, production and transportation of building materials, also contractors should have appropriate planning, maintain current information, on time payments of funds and understanding of project requirement.

Keywords: Building materials, projects, fluctuation, price, performance

INTRODUCTION

The building sector is very crucial in construction industry of any nation's social and economic development. There are many factors responsible for this. Apart from the sector's potential with respect to employment generation, the various activities undertaken in the sector are very relevant to fostering effective sectoral linkages and sustaining economic development (Mathews, 2015).

Housing is a major component of the sector. Housing is a key input in economic, social, and civic development; many housing-related activities contribute directly to achieving broader socio-economic development goals, and it is a major driver of economic growth. The building sector has provided employment for different types of employees, especially in major Nigerian cities where construction activities have been massive like the Federal Capital Territory (FCT), Abuja. The sector is also vital in sectoral connection as its activities have multiplier effects on the growth of other sectors, especially the building materials sector, real estate transactions, among others (Akanni *et al*., 2014). Building materials have been playing an important role in erecting or constructing structures. No field of engineering is conceivable without their use (Akanni, 2016; Udosen and Akanni, 2010). Building materials contribute immensely to the quality and cost of housing, from substructure (foundation) to the superstructure including materials for roofing and finishes.

The cost of building materials poses a significant threat to both the building sector and people aspiring to own houses (Anosike, 2009; Mekson, 2018; Mohammed, 2011; Njoku, 2013). Supporting this view, Jagboro and Owoeye (2014) earlier established that increase in the prices of building materials has effects on the industry because building materials alone account for 50 to 60% of project cost and control about 80% of its schedule. While Idoro and Jolaiya (2010) affirmed that many projects were not completed on time due to the cost of materials, which have been on the increase.

A major constraint in the Nigerian construction industry today has been the rapid inflation and fluctuation in the cost of building materials. Windapo *et al*. (2014) observed that the situations arising from the rapid change in the cost of building materials may degenerate to acute shortages of housing

with the millions of middle- and low-income families being priced out of the market for home ownership all across Nigeria. According to Obadan (2011), government policies set the economic environment in which all sectors operate including the building materials sector. Idoro and Jolaiya (2010), concluded that factors such as the change in government policies and legislations, scarcity of building raw materials, fluctuation in the cost of fuel and power supply, inadequate infrastructural facilities, corruption, fluctuation in the cost of plant and labor, seasonal changes, fluctuation in the cost of transportation and distribution, political interference, local taxes and charges, fluctuation on cost of raw materials, fluctuation in the interest rates and the cost of finance, inflation, and fluctuation in the exchange rate of Naira were many of the recipes for the rising cost of building materials in Nigeria.

These frequent changes and increases give rise to claims, cost overruns, housing supply shortage leading to high cost of urban housing accommodation, construction cost estimate losing usefulness within short periods, difficulty in forecasting and planning, and frequent contract price variations, all of which often leads to project abandonment (Ayodele and Alabi, 2011). Other implications such as completion at the expense of other projects, delay in progress of project works, rate of employment of construction workers, other valuable projects not being commissioned, poor workmanship as a result of the use of low-quality local materials and inhibited innovations in construction methods were identified by Idoro and Jolaiya (2010); Oladipo and Oni (2012); and Windapo *et al*. (2014) as the possible implications of the rising cost of materials. Sinclair, Aibinu (2012) noted that increased material cost is primarily due to increased transport charges. Further, high transport and freight costs have been identified as the factors responsible for building material price fluctuation in African countries such as Nigeria, Uganda, and Kenya (Mathews, 2015).

The research examined the possible factors responsible for building materials price fluctuation in Abuja, Nigeria and determines the impact of materials price fluctuation claims on cost performance of building projects.

Price Fluctuation

Price fluctuation can generally be defined as the rise or fall of price of goods, materials and services on the markets. Price fluctuation can occur at any market i.e at local market or at the labour market, international markets. Fluctuation reasons are numerous, the major ones being (Stukhart 2012) Shortage or excess supply at market, Government's regulation on oil price and decrease or increase in demand of a certain item. Shortage or excess supply at market: the availability of certain item on market has an inverse relationship with the price of the same on the market. If an item is supplied in excess amount on the market, its price will reduce from its normal price, and inversely, if there is a shortage of the same item, then its price will rise. Increase or decrease in demand of a certain item: the price of a certain item has a direct relationship with the demand of that particular item. If the demand for certain item rises, then its price will also rise and vice versa (Entrusty, 2009).

FACTORS RESPONSIBLE FOR BUILDING MATERIALS PRICE FLUCTUATION

The factors responsible for fluctuations in the cost of building materials have been categorized as economic related factors, building production related factors, stakeholders' related factors and external factors (Mojekwu *et al*., 2010).

Demand and Supply

According to Lakka (2009), demand and supply interaction has a significant role to play in the price of materials. When the market is working perfectly so that the supply at a given price and demand at a given price is known, the rational and logical conclusion is that the quantity supplied to the market will be exactly the same with the quantity demanded. Hence, price of goods supplied will be the same with that sold. At a particular time, there may be more goods brought to the market and offered at such a price that not all of them are bought by customers, by so doing fluctuation threatens the prices of these materials.

Energy costs

Monetary and non-monetary costs (such as the environmental impact) associated with the production, transmission, and consumption of energy. According to Bureau of Economic Research (BER) (2008), the prices of, electricity bills, gasoline, coal, renewables and other fuels change quickly, and are acute data points for industry professionals and citizens alike. Clients and building contractors are often best prepared to make decisions if they have current price trend information.

Raw materials and input costs

Raw materials costs along with other factors such as gas, oil and energy are the key causes of fluctuation in the prices of building materials such as cement, water proofing and roof members. The cost that goes into production will have effect on the product either by increasing/reducing the price or reducing/increasing the quality of the product (Ramus, 2011).

Inflation

Inflation is the general skyward trend of prices of services and goods within an economy; it is basically a measure of how the prices of goods and services increase over time, the principle behind inflation and how it affects building material prices according to Rakhra and Wilson (2017) is that there is a time lag between an increase in inflation and the effective resulting increase in building material prices.

Crude oil prices

Crude oil is the base for lots of products. These include transportation fuels such as diesel, gasoline and jet fuel; they also include fuel oils used for electricity generation and heating. Crude oil prices measure the spot price of various barrels of oil. Furthermore, Anderson (2011) noted that the global crude oil price is the main driver behind the instability of some building materials such as PVC, which is a polymer whose raw production material is crude oil.

Exchange rates

The exchange rate between two currencies is the amount for which one currency is exchanged for the other, and is used in determining the strength of one currency to another. The degree to which building material prices are affected by exchange rate movements depend on the types and quantities of materials being imported by a country at a specific time, the need to import the raw materials used in the production of building materials locally, and on whether local materials (such as timber, copper and steel) are internationally traded commodities (Busreport *et al*., 2011)

Import duties

Import duties are put in place to shield local producers from clients trying to outsource cheaper goods from abroad. Import duties on materials have been noted to affect the construction industry and building material prices in countries such as Malaysia, Nigeria, India, Uganda, Kenya and Oman by raising the prices of good imported due to imbalance in export and import rate (Hamsawi, 2011).

Interest rate

The high interest rate of banks and the unpredictability in the foreign exchange market result in serious depletion of a nation's foreign exchange resources, severely affecting the industry with import dependence of about 60% of its raw materials (Jagboro and Owoeye, 2014).

However, Oladipo (2012) opined that across the nation, many construction, housing and profitable real estate projects have either been abandoned half way or put on hold because of the scarcity of capital or because of the sky rocketing cost of borrowing. Aside from the increase in the cost of borrowing, high interest rate also causes reduction in spending as people are more inclined to save. Central Bank of Nigeria interest rate as at April, 2018 was 14%.

Currency devaluation

According Tuffery (2010) Currency devaluation is a tool used by monetary authorities to improve the country's trade balance by boosting exports at moments when the trade deficit may become a problem for the economy. After devaluations, the same amount of a foreign currency buys greater quantities of the country's currency than before the devaluation. This means that the country's services and product are likely to be sold at lower prices in foreign markets, making them more competitive. Devaluation usually takes place when a government notices regular capital outflows (or capital flight) from a country, or if there is a significant trade deficit (where the total value of imports outweighs the total value of exports).

Ordering and delivering process

The order-to-delivery process (ODP) is the principal means by which contractors or customers communicate with suppliers, the final sale transaction is made, and cash is generated for the supplier. The ODP, also known as the OCP (order-to-cash process), is an extremely important core business process in construction industry. It is a contractor-facing process and is the key to operational efficiency and client satisfaction. Can the order processing process create differentiation and competitive advantage? Most certainly yes. Firms should strive to create an ODP that is standard and that results in effective construction (Wahab, 2015).

Human factors

According to Ihuah *et al*. (2015) human factors refer to environmental, organisational, job factors and individual characteristics, which influence behaviour at work in a way which can affect health and safety". This definition includes three interrelated aspects that must be considered: the job, the individual and the organisation:

i. The job: including areas such as the nature of the task, the working environment, workload, controls, the design of displays and the role of procedures.
ii. The individual: including his/her competence, personality, skills, risk perception and attitude. Individual characteristics influence behaviour in complex ways. Some characteristics such as personality are fixed; others such as attitudes and skills may be enhanced or changed.
iii. The organisation: including work patterns, resources, the culture of the workplace, leadership, communications and so on. Such factors are often overlooked during the design of jobs but have a significant influence on individual and group behaviour.

Design changes

Changes in construction projects are always going to happen and cannot be avoided. Changes causes disruption of performance of construction projects, especially cost and time performance. Many factors can be the cause of changes in construction projects; one of the most influential factors is design change (Mansfield *et al*., 2014). The influential factors of design changes can be classified into two groups; the internal factors consist of owner, construction management consultant, design consultant, and contractor, while the external

factors involve economic and political, the natural environment, the third-party and advance of technology.

Material wastage

Construction waste consists of unwanted material produced incidentally or directly by the construction. This includes building materials such as nails, insulations, shingle, electrical wiring and roofing as well as waste originating from site preparation such as dredging materials, rubble and tree strumps. According to Wahab (2015) much building waste is made up of materials such as concrete, bricks and wood unused or damaged for various reasons during construction. Observational research has shown that this can be as high as 10 to 15% of the materials that go into a building, a much higher percentage than the 2.5-5% usually assumed by quantity surveyors and the construction industry. Since considerable variability exists between construction sites, there is much opportunity for reducing this waste.

Supplier default

Nega (2013) noted that the main factor responsible for supplier default come from the fact that some suppliers control a monopoly of the market by keeping the price high and restricting the output, showing non or little awareness of the needs of the customers. The researchers stressed that because of the high demand of some building materials, some suppliers wait for a high accumulation of orders, thereby generating problems associated with importing raw materials as well as increased exchange rates.

Transportation

Okupe (2010) stated that in the construction industry, transportation and logistics are at the core of implementing supply chain management that will gain you a competitive advantage. An effective transportation and logistics system ensures on time delivery of the right materials to your site, while reducing your costs.

Planning

Eshofonie (2016) noted that planning is one of the most important factors affecting the cost of building materials. Contractors should utilise all resources in effective ways. Proper scheduling is essential in project resource utilisation, as the reverse, inadequate planning, will increase the project cost, suggesting that where there is no effective contractor scheduling and planning on site there will be construction project delays.

Market stockpile

Naveen (2015) pointed out that market stockpile is one of the major causes of fluctuating prices of materials; He attributed the fear of fluctuation to the reserves of materials and reluctance to send large quantities to the market despite surging prices that offer huge opportunity making the price go higher. As the materials are stockpiled, it increases its scarcity causing inflating prices for the available ones.

Force majeure

According to Investopadia (2019) Force majeure is a French term that literally means "greater force." It is related to the concept of an act of God, an event for which no party can be held accountable, such as a tornado or hurricane. Force majeure also encompasses human actions, however, such as armed conflict. Generally speaking, for events to constitute force majeure, they must be unforeseeable, external to the parties of the contract, and unavoidable. These

concepts are defined and applied differently by different jurisdictions. Example is the unforeseen impact of the Covid-19 pandemic in recent time.

Weather conditions

Weather changes contribute a enormous challenge to global warming emission of CO2 by buildings under in use and under construction, while building materials are a significant component of any building project, climate change indirectly or directly will also have an effect on the price and use of building materials during or before building construction (Ofeogbu, 2017).

Government policies

According to Mansfield *et al.* (2014), governments may also invoke their powers to initiate or halt projects on social, political and environmental grounds which will eventually lead to fluctuation in materials. No construction work happens in a single space; rather it is subject to a group of powers from regulatory control to political intervention.

RESEARCH METHODOLOGY

The study adopted a survey design approach using quantitative data. Data were collected through well-structured questionnaire administered to respondents and archival data were also collected in table form. The population consisted of 250 registered building contractors gotten from the Corporate Affairs Commission (CAC directory, 2020). The population of 250 were broken into sample frame constituting medium and large building contractors. These respondents were selected because they are the key players in building construction. The value of 250 gotten from sample frame was subjected to (Krejcie and Morgan table, 1970) for determining sample size at 5% limit of error and at 95% confidence level. This was reduced to 152, which is the minimum sample size for this research. Therefore, a total of 170 questionnaires were retrieved out of the 250 distributed. 162 were found valid along with 23 archival data for the analysis, as eight (8) were deemed invalid, because of poor responses. The 162 represents an effective response rate of 95.29% and this was considered suitable for analysis.

A simple random sampling technique was adopted in the questionnaire distribution. The questionnaire was designed and contains tables and check-boxes for easy selection of options by respondents; which was divided into two (2) main parts. Part A - is related to demographic information of the respondents and their companies. Part B- asked questions about factors influencing material price fluctuation in Abuja reflecting the major areas of the study interest, thereby providing information relevant to the study objectives and answering the research questions. A 5-point Likert scaled questions and options were designed for data collection. The collected data were analysed using Percentile, Relative Importance Index (RII) and Pearson Correlation Moment Data processing was done with the aid of Microsoft Excel 2010 to determine the impact of materials price fluctuation claims on cost performance.

RESULTS AND DISCUSSION

Demographic information of the respondents

Result in Table 1 shows the characteristics of the respondents. From the table, it shows that the highest number of respondents years of experience is between 11-15 years (30.2%) followed by 6-10 years (24.7%). The highest range of the contract sum handled by most of the respondents was from 51 to 100 Million (27.8%). This indicates that most of the respondent

has handled construction projects involving significant sums. The level of education of respondents was sampled to find out the highest ladder each of the respondents has reached. However, it was not surprising that, majority of the respondents were holders of Bachelor's Degree with 24.1% followed by 19.8% of them being identified in holding a Master's Degree. In term of professional membership, 80% of the respondents are members of their professional bodies while only a lesser fraction of the entire population are none members. As a result, respondents in this study are associated with impressive academic backgrounds, supported by either accreditation of professional status from professional institutes or academic achievement in recognized academic institutions; hence their response to the research questions can be relied upon.

Factors Responsible for Material Price Fluctuations in Building Construction Projects

Table 2 indicates that exchange rate of national currency, cost of transportation, inflation of building materials and cost of energy (fuel, electricity, gas) with RII values of 0.95, 0.93, 0.92 and 0.91 respectively are ranked as the top four important factors responsible for material price fluctuations in building construction projects.

Table 1: Demographic information of the respondents

Category	Classification	Frequency	Percentage
Years of experience	1-5	24	14.8
	6-10	40	24.7
	11-15	49	30.2
	16-20	26	16.0
	Above 20	23	14.1
	Total	162	100.0
Highest range of contract sum involved	1-10 Million	35	21.6
	11-50 Million	40	24.7
	51- 100 Million	45	27.8
	101- Above	42	26.0
	Total	162	100.0
Academic qualification	OND	18	11.1
	HND	30	18.5
	PGD	28	17.3
	B.Sc./B.Tech.	39	24.1
	M.Sc./M.Tech.	32	19.8
	PHD	15	9.3
	Total	162	100.0
Professional Qualification	MNIA	35	21.6
	MNIOB	31	19.1
	MNSE	36	22.2
	MNIQS-	36	22.2
	None	24	14.8
	Total	162	100.0

Source: Researcher's field survey (2020).

Among the least ranked factors responsible for building materials price fluctuation includes: frequent weather condition change, force majeure (An act of God), and material wastage on site, each with RII of 0.61, 0.56 and 0.53 respectively.

Table 2: Factors Responsible for Material Price Fluctuations in Building Construction Projects

S/N	Material Price Fluctuations Factors	RII	RANK
1	Exchange rate of currency	0.95	1
2	Cost of transportation	0.93	2
3	Inflation of building materials	0.92	3
4	Cost of energy (electricity, gas)	0.91	4
5	Government policies on materials	0.86	5
6	High import duties rates on materials	0.81	6
7	Raw materials and input costs of building materials production	0.80	7
8	Increasing interest rate	0.80	8
9	Political instability of the nation	0.77	9
10	Rapid devaluation of national currency	0.77	10
11	level of supply and demand	0.77	11
12	Unstable crude oil prices	0.76	12
13	Ordering and delivering process of building materials	0.75	13
14	Suppliers default to make materials available at the needed time	0.75	14
15	Availability of substitute product	0.74	15
16	Ineffective planning	0.72	16
17	Market stockpile of needed materials	0.71	17
18	Human factors	0.71	18
19	Frequent design changes	0.71	19
20	Frequent weather condition change	0.61	20
21	Force majeure (An act of God)	0.56	21
22	Material wastage on site	0.53	22

Source: Researcher's field survey (2020).

Impact of Materials Price Fluctuation Claims on Cost Performance of Building Projects

Table 3 shows the correlation analysis performed to determine the relationship between materials price fluctuation claim sum and total project cost.

Table 3: Impact of Materials Price Fluctuation Claims on Cost Performance of Building Projects

Project No	Initial project cost (₦)	Final project cost (₦)	Material Fluctuation claims (₦)	Percentage Contribution
1	36,890,000.00	42,732,000.00	1,480,000	3.46
2	92,000,000.00	100,300,272.00	480,000	0.48
3	40,977,574.08	46,099,770.84	2,355,087.4	5.11
4	46,083,600.00	51,844,050.00	1,500,000	2.89
5	45,512,288.00	49,201,324.00	1,800,300	3.66
6	213,648,783.60	250,000000	6,080,073	2.43
7	276,931,365.20	301,500467	3,120,000	1.03
8	87,300,000.00	116,100,000.00	5,168,000	4.45
9	14,200,000.00	19,800,000.00	1,254,000	6.33
10	20,100,000.00	25,789,000.00	268,000	1.04
11	6,785,230.00	8,991,694.40	397,163.7	4.42
12	87,377,000.00	106,136,000.00	2,560,000	2.41
13	142,000,000.00	150,125,200.25	6,800,000	4.53
14	130,610,025.63	155,625,000.00	8,088,001	5.20
15	48,255,650.00	66,755,548.22	4,200,020	6.29
16	35,000,000.00	40,045,850.00	2,000,000	4.99
17	1,380,000,000.00	1,500,000,000.00	36,280,021	2.42
18	22,226,680.20	28,226,365.55	1,680,000	5.95
19	19,233,000.00	31,325,225.21	2,200,009	7.02
20	100,000,000.00	145,000,000.00	8,320,000	5.74
21	500,000,550.00	523,700,000.00	12,004,540	2.29
22	1,600,800,000.00	1,790,000.400.25	28,000,605	1.56
23	740,090,000.00	760,000,350.42	18,550,000	2.44

Source: Researcher's field survey (2020).

The analysis reveals that there was a very strong, positive correlation with the significance level (p value) of 0.01. This implies that constant fluctuation claims due to materials prices will lead to a corresponding fluctuation in the final project cost.

Moreover, the percentage impact of fluctuations claims to a total project cost ranges from 0.48% to a maximum of 7.02% with an average of 3.75%

CONCLUSION AND RECOMMENDATIONS

This research assesses the factors responsible for building materials price fluctuation with a view to minimising the resultant effects on contractors. Based on the findings, the study concludes that the major factors that are responsible for building materials price fluctuation are: exchange rate of national currency, cost of transportation, inflation of building materials and cost of energy (fuel, electricity, gas). The study also established that fluctuation claims due to materials prices will lead to a corresponding change, most especially increase in the final project cost. However, in order to provide lasting solutions and bring about steady building material prices and avoid circumstances of constant price fluctuation, It is recommended that drastic steps should be taken by Government to stabilise naira exchange rate, reduce cost of energy, production and transportation of building materials, also a building material monitoring committee should be set to bring innovations in construction materials research and methods. Periodical material research will help curb the continuous increases in price of building materials. Furthermore contractors should have appropriate planning, maintain current information, on time payments of funds and understanding of project requirement.

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Assessment of the Effect of Materials Procurement Risks Factors on Time, Cost and Quality Performance of Building Projects in Abuja, Nigeria

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Abstract:

The challenges involved in materials procurement in building projects, risks still remain a serious problem requiring urgent attention in the Nigerian building construction industry. This problem could be attributed to little understanding of materials procurement risk management strategies by procurement officers, project managers and contractors who are affecting the performance of building projects. This research assessed the effect of materials procurement risk factors on time, cost and quality performance of building projects in Abuja, Nigeria. The study adopted a survey design approach using quantitative data. Data were collected through well-structured questionnaire administered to 159 respondents who are project managers, contractors, heads of waste management departments, and consultants of 61 active building construction sites that are practicing lean within Abuja using judgemental sampling method. A total of 139 questionnaires were retrieved from 159 distributed. The collected data were analysed using descriptive methods, including frequencies, percentages and Mean Item Score (MIS). The study revealed that the materials procurement risk factors that have high effect on time performance of building project are: inflexible design; new and existing competitors; and unexpected changes in demand with MIS values of 3.99, 3.95, and 3.92. It was also found that the materials procurement risk factors that have high effect on cost performance of building project are: inflation; and quality control and assurance with MIS values of 3.99 and 3.90. The research also found that the materials procurement risk factors that have high effect on the quality performance of building project are: differing site condition; and changes in interest rates with MIS values of 3.96 and 3.95. Based on these findings it can be concluded that the building materials procurement risks identified in this paper are relevant in building construction projects. This will help professionals in identifying and taking necessary measures in preventing risks in building construction projects in Nigeria.

Keywords: Materials procurement, Risk, Risk management, and Building construction project

INTRODUCTION

The construction industry contributes to the socio-economic growth of any nation by improving the quality of life, generating employments and providing the infrastructure, such as roads, hospitals, schools, and other basic facilities. Hence, it is imperative that construction projects are completed within the scheduled period of time, within the budgeted cost, and meet the anticipated quality (Saidu and Shakantu, 2016).

Materials procurement are significantly influenced by various factors such as: improper materials handling and management on site during construction production processes (Khyomesh and Vyas, 2011). As a result, materials procurement strategies have been observed to influence the quality, time and socio-economic sustainability of the project. However, challenges arising from poor materials procurement on construction sites still persists including errors in ordering materials, difficulties in ordering materials in small materials; delays in material delivery, problems associated with material transportations, handling and storage, production of defective materials and general poor resource control on site (Glass *et al.*, 2014; Aibinu and Odeyinka, 2016; Bossink and Brouwers, 2015; Poon *et al.*, 2014; Formoso *et al.*, 2012). Material in particular covers about 60% of total construction cost (Kasim *et al.*, 2016; Gulghane and Khandve, 2015; Patil *et al.*, 2013 and Ibironke, 2013). Moreover, the rising price of building materials and the escalating cost of construction have become topical in many

countries (Amusan *et al.,* 2017; Tunji-Olayeni and Omuh, 2013). Hence, efficient material procurement holds great potentials for significant cost savings for construction projects (Amusan, *et al.,* 2017). Kolenko (2016) states that risk in procurement is measured from a transactional point of view where risk management is dedicated to things that can go wrong in the procurement process. Risk identification is widely accepted to be the first and the key step of material procurement risk management process, because of the fact that all the succeeding steps and actions will be based on it.

Research has shown that delays in project deliveries have resulted in client and contractor disputes, litigations and project abandonment, cost and time over-run. Kasim *et al.* (2016) in their individual studies, stated that the adoption of effective procurement strategy – especially in acquiring materials - will ensure project success and clients' satisfaction. However, Linden and Josephson (2013) posited that the process of selecting the most appropriate procurement strategy for materials acquisition in a project primarily been a source of concern to the contractor. Consequently, understanding the main categories of risk faced in the materials procurement process will assist in risk assessment and planning, and devising the management and operational measures that will be taken to mitigate those risks (United Nations Procurement Practitioners Handbook, 2012).

The aforementioned challenges have become enormous problems faced by Nigerian construction companies in the management of materials procurement which is the bane of successful project delivery. It is against these backdrops that this study assesses the effect of building materials procurement risks in Abuja, with a view to recommending the endemic problems of materials procurement risks in building construction projects in Nigeria.

MATERIAL PROCUREMENT RISKS IN BUILDING CONSTRUCTION

Procurement risk is defined as the possibility of failures in a procurement process (Harland *et al.,* 2013). Procurement risk includes; cost, quality, fraud, and delivery (Hatush and Skitmore, 2012). Kolenko (2016) states that risk in procurement is measured from a transactional point of view where risk management is dedicated to things that can go wrong in the procurement process. This transactional point of view is concerned with actions that may contribute towards failure to comply with the required procurement process, inadequacy of the procurement process to achieve the commercial outcome, and a break down in the procurement process (Sim and Pabala, 2012). Companies often overlook procurement decisions, and this may lead to major difficulties in completing the project (Martindale, 2015).

A construction company faces many challenges, which include discontinuity and disruption in the procurement of essential materials, unavoidable increases in project costs and in unit costs of purchased materials, both immediate and long-term loss of power and impact on relationships with essential suppliers, inability to meet customer demand, procurement functions that do not support organisational objectives, factors that weaken a company's ability to respond with speed and agility to meet changing circumstances, opportunity for fraud and corruption during the tendering process, and negative impact on reputation in the market place (Ritchie *et al.,* 2012). Fundamental challenges during procurement in the construction industry comprises of external factors such as labour, safety or other laws, nuclear pollution, supersonic bangs damage due to war, government policy on taxes, industrial disputes, and malicious damage to property (Teresa *et al.,* 2015). These challenges often give rise to procurement risk in the company (Muelbrook, 2012). Speculative risk is something which can be allocated in advance as decided by the parties in the contract (Seifbarghy, 2014). This may involve loss of

time and money, as a consequence of exceptionally adverse weather, unforeseeable shortages of labour or materials, unexpected ground conditions, and other similar difficulties beyond the control of the contractor (Zsidisin and Smith 2015). Ho *et al.*, 2015 have identified five categories of material procurement risks: macro, demand, manufacturing, supply and infrastructural (information, transportation, and financial) factors. Other external risks include floods, terrorism, strikes, natural disasters (Chacon *et al.*, 2011).

Rao and Goldsby (2015) expressed the need for a typology that explicitly identifies the potential sources of risk in the material procurement. They provided a comprehensive literature review on material procurement risk management and developed a typology of risk sources for the material procurement, comprising of industry factors (for instance new and existing competitors, fluctuations in users' demand and shifts in market supply), environmental factors (like war, changes in government policy or regulations, price fluctuations, and changes in interest rates), decision-maker related factors (like knowledge of decision makers), organizational factors (for instance raw materials shortages, machine failure, and labour uncertainties) and problem-specific factors (like complexity of decision tasks) (Saha, 2015). Given the comprehensiveness of Rao and Goldsby's (2015) literature review, it would be inappropriate to repeat similar details here and hence, their work can be adopted and tested in a new context (construction). Such analysis will provide valuable insights for researchers and practitioners who are interested in construction material procurement management. Hence, risk factors that may suit construction Material procurement in the Nigerian setting were identified. Table 1 shows the potential risks factors that are likely to occur in construction material procurement of building in Nigeria identified from literature.

RESEARCH METHODOLOGY

This study adopted a survey design approach using quantitative data. Survey design was suitable for this study because the factors considered are those identified from the literature to which their applicability in construction project is to be verified. Data was collected through structured questionnaire administered to respondents within Abuja, the Federal Capital Territory (FCT) of Nigeria. Abuja was selected because it is one of the epicentre of construction activities in Nigeria. The targeted population for this research constitutes the major construction participants within Abuja. The population of this research constitutes 62 active building construction projects sites in Abuja, gotten from Federation of Construction Industry in Nigeria (FOCI directory, 2019).

Table 1: Potential Risks in Construction Material Procurement

S/N	RISK FACTORS
1.	Policy changes
2.	Fluctuations in prices
3.	Natural occurrences for instance fire
4.	Shortage of raw materials
5.	Unexpected changes in demand
6.	New and existing competitors
7.	Bad debt
8.	Changes in interest rates
9.	Uncertain research and development results
10.	Labour uncertainties (for instance strikes)
11.	Frequent changes in supply chain inputs

12. Fragmented decision-making
13. Quality/excessive snagging
14. Inappropriate design for scheme
15. Site impact on local community
16. Incompetency of site management
17. Volatility of supply chain workflow
18. Ineffectiveness of arrangements
19. New technology or technique
20. Inconsistency of suppliers
21. Inflexible design
22. Experience of subcontractors
23. Incompetency of project team
24. Security
25. Responsiveness of suppliers
26. Changes in quantity/scope of work
27. Inflation
28. Quality control and assurance
29. Difficulties/delays in availability of materials, equipment and labour
30. Bureaucratic problems
31. Inadequate specifications
32. Permit and approval
33. Owner and contractor experience
34. Site access/right of ways
35. Design changes
36. Third party delay and default
37. Financial failure-any party
38. Differing site conditions (unforeseen site conditions)
39. Delay in design/redesign if over budget
40. Exceptionally inclement weather

The population of 62 actives construction sites were broken into sample frame constituting one each of the following respondents: procurement officers; project managers; site managers and contractors, making a total of 248 respondents within the study area. These respondents were selected because they are the key players in managing materials procurement risks in building projects. The value of 248 gotten from sample frame was subjected to Taro Yamane (Yamane, 1973) formula for finite population for determining sample size at 5% limit of error and at 95% confidence level. 248 was reduced to 153, which is the minimum sample size for this research. Therefore, a total of 139 questionnaires were retrieved out of the 153 distributed. 139 were found valid for the analysis, as 14 (14) were deemed invalid, because of poor responses. The 153 represents an effective response rate of 96.83% and this was considered suitable for analysis (Alreck and Settle, 1985).

This study adopted stratified random sampling method, because respondents were first categorized into different strata/groups, that is: procurement officers, project managers, site managers and contractors and they were selected and randomly sampled accordingly. Hence, Laerd Dissertation (2012) noted that probability sample require that every member of the population has a known and non-zero chance of being selected in the sample. A multi-choice type questionnaire was designed for this research. The questionnaire contains tables and check-boxes for easy selection of options by respondents. The questionnaires were structured in a

manner that allows respondents to select from the answer choices provided. The questionnaire reflects the major areas of the study interest, thereby, providing information relevant to the study objectives and answering the research questions. The questionnaire asked questions on a 5-point Likert scale.

The questionnaire was divided into two (2) main parts. Part A - is related to demographic information of the respondents and their companies. Part B- asked questions on the effect of the materials procurement risks on time, cost and quality performance of building projects.

Some of the questionnaires were collected same day of their administering, while others were collected from the respondents after some days. This is due to the level of engagement of most of the respondents who were too busy with site works to attend to the questionnaires immediately. In addition, the distances separating one construction sites to the other, contributed to the inability of the researcher to get all the questionnaires on same day. However, with a repeated visit and follow-up calls on the need for the questionnaires to be attended to, a good number of the respondents did give their responses and the questionnaires collected. In order to achieve the aim of this research, the descriptive method of analysing data was employed and this included the use of percentile and Mean Item Score (MIS).

RESULTS AND DISCUSSION

This section presents and discusses the results of this study by linking the results to existing findings in the literature.

Demographic information of the respondents

Result in Table 2 shows that most of the respondents sampled (77.59%) are males while 22.41 % are females.

Table 21: Demographic information of the respondents

Category	Variables	Frequency	Valid percent
Gender	Male	107	77.59
	Female	32	22.41
	Total	139	100
Profession	Contractors	56	40.07
	Procurement officers	33	23.15
	Site managers	31	22.89
	Project managers	19	13.89
	Total	139	100
Years of Experience	Less than 5years	21	15.74
	5-10years	39	27.78
	11-20years	46	33.33
	21-30years	25	17.59
	Above 30	8	5.56
	Total	139	100
Academic qualification	ND	8	5.56
	HND	30	21.30
	BSc/Btech	75	53.70
	MSc/Mtech	17	12.96
	Others	9	6.48
	Total	139	100%

Source: Researcher's analysis (2020).

In terms of professionals' representation, the result revealed that contractors (40.07%) are more, followed by procurement officers (23.15%), then site managers (13.89%) and lastly project managers (13.89%). A look at the year of work experience of the respondents shows that only 15.74% of them have their year of working experience to fall within less than 5 years range, while 27.78% and 33.33% falls between the range of 5 to 10 and 11 to 20 years respectively. Also 17.59% and 5.56% of the population falls between the ranges of 21 to 30 years and above 30 years respectively. However, the average years of working experience of the respondents is calculated as approximately 10.75 years. This implies that they are experienced enough to give a valid response.

In terms of academic qualification, the highest is BSc/MTech (53.70%), followed by HND (21.30%), then MSc./MTech (12.96%), ND and Others are 5.56% and 6.48% respectively.

Based on the result on the respondents' background information, it was concluded that the respondents are well equipped professionally and in terms of experience to give reasonable insight in the subject under consideration.

Effect of the materials procurement risks on time, cost and quality performance of building projects is as presented in Table 3

Table 3: Effect of the materials procurement risks on time performance of building projects

S/No	Time performance risk factors	MIS	Rank	Decision
1	Inflexible design	3.99	1	Very High
2	New and existing competitors	3.95	2	Very High
3	Unexpected changes in demand	3.92	3	Very High
4	Inappropriate design for scheme	3.83	4	Very High
5	Bad debt	3.80	5	Very High
6	Design changes	3.71	6	Very High
7	Inadequate specification	3.66	7	Very High
8	Shortage of raw materials	3.65	8	Very High
9	Force majeure	3.64	9	Very High
10	Delay in design/redesign if over budget	3.54	10	Very High
11	Responsiveness of suppliers	3.53	11	Very High
12	Volatility of supply chain workflow	3.53	11	Very High
13	Exceptionally inclement weather	3.51	13	Very High
14	Incompetency of project team	3.49	14	High
15	Policy changes	3.46	15	High
16	Permit and approval	3.45	16	High
17	Ineffectiveness of arrangements	3.39	17	High
18	Bureaucratic problems	3.36	18	High
19	Incompetency of site management	3.32	19	High
20	Inconsistency of suppliers	3.18	20	High
21	Difficulties/delays in availability of materials, equipment and labour	3.14	21	High
22	Site access/right of ways	3.00	22	High
23	Financial failure-any party	3.00	23	High
24	Differing site conditions (unforeseen site conditions)	3.00	24	High
25	Experience of subcontractors	2.96	25	High
26	Third party delay and default	2.71	26	High
27	Owner and contractor experience	2.57	27	High
28	Changes in quantity/scope of work	2.36	28	Moderate

Source: Researcher's Field Survey (2020).

Table 3 shows the materials procurement risk factors that have high effect on time performance of building project are: inflexible design; new and existing competitors; unexpected changes

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in demand; inappropriate design for scheme; bad debt; design changes; inadequate specification; shortage of raw materials; force majeure; and delay in design/redesign if over budgeted.

The MIS values are 3.99, 3.95, 3.92, 3.83, 3.80, 3.71, 3. 3.66, 3. 3.65, 3. 3.64, 3. 3.54 respectively. These findings are in line with the conclusion of Helbing *et al.* (2016) that the risks have high effect on materials procurement of building projects. However, differing site conditions (unforeseen site conditions); experience of subcontractors; third party delay and default; owner and contractor experience; changes in quantity/scope of work with MIS values of 3.00, 2.96, 2.71, 2.57, 2.36 has the least effect on time performance of building project.

Effect of the materials procurement risks on cost performance of building projects

Table 3 indicates that the materials procurement risk factors that have high effect on cost performance of building project are: inflation; quality control and assurance; new technology or technique; difficulties/delays in availability of materials, equipment and labour; security; labour unrest; bureaucratic problems; fluctuations in prices; owner and contractor experience; and changes in quantity/scope of work with MIS values of 3.99, 3.90, 3.89, 3.87, 3.80, 3.79, 3.76, 3.75, 3.74, 3.73 respectively. The least effect on cost performance of building project are: shortage of raw materials; site impact on local community; unexpected changes in demand; inadequate specifications; financial failure-any party with MIS values of 3.24, 3.19, 3.14, 3.09, 2.99 respectively.

Table 3: Effect of the materials procurement risks on cost performance of building projects

S/N	Cost performance risk factors	MIS	Rank	Decision
1	Inflation	3.99	1	Very High
2	Quality control and assurance	3.90	2	Very High
3	New technology or technique	3.89	3	Very High
4	Difficulties/delays in availability of materials, Equipment and labour	3.87	4	Very High
5	Security	3.80	5	Very High
6	Labour uncertainties (for instance strikes)	3.79	6	Very High
7	Bureaucratic problems	3.76	7	Very High
8	Fluctuations in prices	3.75	8	Very High
9	Owner and contractor experience	3.74	9	Very High
10	Changes in quantity/scope of work	3.73	10	Very High
11	Changes in interest rates	3.71	11	Very High
12	Bad debt	3.67	12	Very High
13	Frequent changes in supply chain inputs	3.51	13	Very High
14	Policy changes	3.47	14	High
15	Force majeure	3.41	15	High
16	Design changes	3.38	15	High
17	New and existing competitors	3.38	17	High
18	Uncertain research and development results	3.37	17	High
19	Differing site conditions (unforeseen site conditions)	3.37	19	High
20	Changes in quantity/scope of work	3.27	20	High
21	Shortage of raw materials	3.24	21	High
22	Site impact on local community	3.19	22	High
23	Unexpected changes in demand	3.14	23	High
24	Inadequate specifications	3.09	24	High
25	Financial failure-any party	2.99	25	High

Source: Researcher's Field Survey (2020).

Effect of the materials procurement risks on quality performance of building projects

Table 4 shows that the materials procurement risk factors that have high effect on the quality performance of building project are: differing site condition (unforeseen ground conditions); changes in interest rates; incompetency of site management; responsiveness of suppliers; quality control and assurance; inflexible design; inconsistency of supplies; bad debt; changes in quantity/scope of work; force majeure with MIS values of 3.96, 3.95, 3.91, 3.91, 3.87, 3.82, 3.81, 3.75, 3.75, 3.74 respectively. The least effect on Quality performance of building project are: quality/excessive snagging; labour uncertainties (for instance strikes); frequent changes in supply chain inputs; inadequate specifications; owner and contract experience with MIS values of 3.67, 3.66, 3.65, 3.60, 3.58 respectively.

Table 4: Effect of the materials procurement risks on quality performance of building projects

S/No	Quality performance risk factors	MIS	Rank	Decision
1	Differing site condition (unforeseen ground conditions)	3.96	1	Very High
2	Changes in interest rates	3.95	2	Very High
3	Incompetency of site management	3.91	3	Very High
4	Responsiveness of suppliers	3.91	3	Very High
5	Quality control and assurance	3.87	5	Very High
6	Inflexible design	3.82	6	Very High
7	Inconsistency of suppliers	3.81	7	Very High
8	Bad debt	3.75	8	Very High
9	Changes in quantity/scope of work	3.75	8	Very High
10	Force majeure	3.74	10	Very High
11	Incompetency of project team	3.71	11	Very High
12	Shortage of raw materials	3.69	12	Very High
13	Experience of subcontractors	3.69	12	Very High
14	Unexpected changes in demand	3.67	14	Very High
15	Quality/excessive snagging	3.67	14	Very High
16	Labour uncertainties (for instance strikes)	3.66	16	Very High
17	Frequent changes in supply chain inputs	3.65	17	Very High
18	Inadequate specifications	3.60	18	Very High
19	Owner and contract experience	3.58	19	Very High

Source: Researcher's Field Survey (2020).

CONCLUSION AND RECOMMENDATIONS

The challenges involved in materials procurement in building projects, risks still remains a serious problem requiring urgent attention in the Nigerian building construction industry. This problem could be attributed to little understanding of materials procurement risk management strategies by procurement officers, project managers and contractors which is affecting the performance of building projects. This research assessed the effect of materials procurement risks factors on time, cost and quality performance of building projects in Abuja, Nigeria. The study concludes that the inherent building materials procurement risks in building projects are: inflation; third party delay and default; uncertain research and development results; ineffectiveness of arrangements; shortage of raw materials and quality/excessive snagging.

The study concludes that the building materials procurement risks that impact more on cost, time and quality performance of building project are: Inflexible design; unexpected changes in demand; bad debt; inflation; quality control and assurance; security; differing site condition; responsiveness of suppliers; and quality control and assurance.

Based on this conclusion, it can be recommended that a competent procurement officers having good pricing and negotiation skills be appointed for building material procurement on construction sites and to also prevent risks due to time, the contractor ought to create contract provisions and project processes to create a clear expectation of the temporal requirements for planning, producing, and managing the project.

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Participation of Female Quantity Surveyors in the Nigerian Construction Industry

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Abstract

Female Quantity Surveyors' participation in the Nigerian construction industry is low, but the reasons for such low participation are not well understood. The study assessed the factors driving, as well as challenges that hinder participation of female Quantity Surveyors (QSs) in the Nigerian construction industry. Data was collected through a self-administered questionnaire survey of 78 male and 110 female QSs in the public and private sector in Abuja. Male respondents were randomly sampled while a census of the female QSs was taken. Analysis of data was carried out using frequency counts, percentile, mean score and T- Test. The most important key motivational factor driving female QSs' participation is "completion of a construction-related course of study". On the other hand, "Unsociable work hours" and "denial of professional activity by colleagues due to family commitment" are the two top challenges encountered by female QSs. It was thus recommended that to improve the level of participation of female Quantity Surveyors, the female QSs should be motivated through freedom to exercise and experiment new ideas, discretion to make decisions and take the initiative in their assigned roles.

Keywords: Construction industry, Female, Participation, Quantity Surveyors

INTRODUCTION

In most developed countries the representation of female workforce has greatly increased. As a result, women are entering traditionally considered male dominated jobs due to economic reasons and changes in the worksite settings (Jaafar *et al*., 2014). The need for unbiased utilisation of human resources has given research motivation to gender participation in various economic endeavours both in the developed and the developing countries (Adeyemi, 2015). Jimoh *et al.* (2016) described women as a hidden human resource which remains largely untapped. There has been rising global consciousness both at the grassroots and national levels, regarding the impact of gender, issues on education and national development (Aguele and Agwagah, 2007; Akinsowon and Osisanwo, 2014 cited in Dada, 2017). The Quantity Surveying (QS) profession faced countless challenges in its development when it first came into existence (Joel, 2016). Despite those challenges it has grown and survived the storms to an extent that today it is a notable profession in the Nigerian construction industry but with few women on board. However, due to the importance of both gender and the challenges facing women in construction industry, Jimoh *et al.* (2016); Adeyemi *et al.* (2006); and Akinsiku and Ajala (2018) investigated the barriers to females' involvement in the Nigeria construction industry. Tunji-Olayeni *et al*. (2018) assessed job satisfaction of female construction professionals (Architects, Builders, Quantity Surveyors and Engineers) in male dominated fields specifically construction industry. Adogbo *et al.* (2015) developed a framework for attracting and retaining women in construction practice. Odubiyi (2018) affirmed that the new trend of diversification noticeable among female construction professionals is a positive one, which is a welcome development since it will enhance profits generation for these professionals and in the long run, improve the economic situation. All these researchers emphasised on females in the construction industry in general.

However, based on the importance of cost to successful completion of any project, a research on female professionals saddled with cost management is vital. Jaafar *et al.* (2016) assessed

the duties and competencies of female quantity surveyors in discharging their duties in construction industry, while Dada and Jagboro (2012) investigated core skills requirement and competencies expected of both male and female quantity surveyors. The findings of these studies revealed that women possess qualities and abilities that are important to enable them to be successful in the construction industry. Studies that investigated challenges facing female quantity surveyors in the Nigerian construction industry are few. Against the backdrop of present-day awareness of gender equality, this is worrisome because the factors that drive or hinder the level of participation of female quantity surveyors are still not fully understood. This is in spite of the efforts of professional associations such as the Women Association of Quantity Surveyors of Nigeria (WAQSN) which is an affiliate of the Nigerian Institute of Quantity Surveyors (NIQS) in creating awareness for females to practice quantity surveying in Nigeria.

In addition, a preliminary survey conducted in the study area for this research revealed that the number of female Quantity Surveyors (QSs) in both public and private practice within Abuja stands at 110, which is low by an order of magnitude, compared to the number of males which was 1,002. No study was found that addressed female Quantity Surveyors' participation in the Nigerian Construction Industry (NCI) within the Abuja FCT area, and which specifically examined the possibility of the existence of certain factors responsible for low participation. This is a research problem which it is impossible to address without an in-depth study of current levels of participation of female QSs in Abuja. This is the gap in knowledge, the filling of which this study has contributed to. In order to address the research problem, the study set out to investigate female quantity surveyors' participation in the NCI towards the attainment of successful project objectives. Two objectives were pursued in order to achieve this: examining the key motivational factors influencing female QSs' participation, and examining the challenges encountered by female QSs in the course of participation in the construction industry.

LITERATURE REVIEW

Quantity Surveying (QS) was defined by The Nigerian Institute of Quantity Surveyors (NIQS) (2004) as "the occupation that is concerned with financial integrity and achieving value for money in the conceptualization, planning, and execution of building and engineering projects and developments". However, over the years, the quantity surveyors' roles have changed which makes the present-day quantity surveyors' competencies to be showcased in varied aspects within the construction industry as well as outside of the construction industry (Hay, 2015). The profession is versatile hence, making provision for anyone in the field to be able to work in several places which includes quantity surveying firms, construction companies, property development or estate management firms and organisations that deal with a reasonable amount of building or construction procurement as part of their activities (Hafiei and Said, 2008). According to Jimoh *et al.* (2016), some of the best strategies for motivation of women for continuous participation in construction-related professions (which includes quantity surveying), are making young women aware of opportunities in construction and better representation of women within the industry. According to Dainty et al. (2000) as cited in Jimoh *et al.* (2016)), flexible working hours and creating scholarship opportunities for women to pursue academic or professional degrees in the built environment are good strategies to improve women involvement in construction.

The challenges to women participation according to English and Lejeune (2012) as cited in Hay (2015) continue to exist and can be categorised as a lack of knowledge about the industry,

poor image, the effect of societal roles and cultural beliefs, traditional roles, lack of role models, poor remuneration, discrimination, hostile work conditions and a male-dominated culture. With respect to constraints and opportunities in the labour market much of the literature on gender discrimination focuses on the lack of education, societal perceptions, the glass ceiling, the queen bee syndrome and work–life balance issues especially for women aspiring to positions of leadership (Mathur-Helm, 2011; English and Lejeune, 2012 as cited in Hay 2015). Arroyo *et al*. (2018) opined that both women and men perceive gender bias in the construction industry, with a larger portion of men however thinking that gender bias is not an issue. The results obtained by Madikizela and Haupt (2010) and cited in Hay, 2015) from a study of industry stakeholders revealed that the few women that were employed each year by construction firms were mostly assigned secretarial and administrative roles. Gyasi (2012) also supports this belief that more women are engaged in marginal roles like labourers and secretaries. The Royal Institution of Chartered Surveyors (RICS) has a global membership of 100,000 Chartered Surveyors; only 10 per cent of this number are female (Ellison (2003) as cited in Hay (2015)).

It is evident that the under-representation of women in construction is not confined to Africa alone. This under-representation of females and consequent perception of the construction industry as male-dominated are due in part to family commitments such as marriage and childbirth (Akinsiku and Ajala, 2018). It was established that the possibility of equal opportunity for both males and females exists in the industry, based on the study by Mohammaden (2013) in the Middle East. The study's findings revealed the proportions of construction organisations that accord women equal chances as men: 66% in office work, 48% in task work on site, and 22% provide separate facilities to women. In addition, 48% of organisations have a distinct and clear policy on non-discrimination when hiring, training and gathering information on the basis of sex. Mohammaden (2013) also found that while 96% of organisations give females the opportunity to get promoted up the organisational ladder, the lack of flexibility in working conditions is an impediment to female entry into the industry.

RESEARCH METHODOLOGY

This study is concerned with the participation of women quantity surveyors (WQS) in the Nigerian construction Industry (NCI). From anecdotal evidence as well as from past studies, WQS are very noticeable minority in the industry (Oyewobi *et al*., 2018). The study was quantitatively conducted through a questionnaire survey. The questionnaire was grouped into three sections; Section A collected demographic information about the respondents, Section B assessed the barriers to women participation and Section C dealt with factors that encourage women participation. Responses were collected using a 5-point *Likert* scale. The questionnaire was self-administered to the respondents. Pre-testing of the questionnaire before administration to the larger population was carried out on ten quantity surveyors who had acquired more than 10 years working experience and knowledge of the research subject matter. Their comments helped in fine-tuning the questionnaire.

The population of the study consists of total number of registered members of the NIQS in the study area who are financially up to date; there were 345 such members. This number included male and female QSs in both public and private sectors in Abuja. Information obtained from the Abuja Chapter of WAQSN revealed that there were 110 women quantity surveyors (WQS). A census of all available and accessible WAQSN members was undertaken while simple random sampling was employed in selecting 78 male QSs (which translates to 33 percent of

the male population) when administering the questionnaire. This resulted in a sample size of 188. This was the number of questionnaires that were self-administered to the respondents; 137 were retrieved, giving a response rate of 73%, which was considered adequate for the purposes of the study. Analysis of the collected data was carried out using descriptive statistics (frequency, counts, percentiles, mean scores) and inferential statistics (t-test) with the aid of the Statistical Package for Social Science (SPSS) Version 20.

DATA ANALYSIS

Factors driving female QS participation in the construction industry

The factors driving female QSs' participation in construction activities in the study area as ranked by the respondents are presented in Table 1. Overall, the respondents ranked 'Studying construction courses in tertiary institutions' as the most influential factor that drives female quantity surveyors' participation in construction activities, based on a mean score of 3.31; female respondents however ranked it 2nd. With an overall mean score of 3.11, 'Enjoyment of daily work tasks' was ranked 2nd by both sexes; female respondents however ranked it 1st in contrast to the male respondents who ranked it 8th. 'Supplementing spouse's income' was ranked 3rd by both sexes (overall mean score of 2.96) and 4th by female respondents only.

Table 1: Factors driving female Quantity Surveyors participation

S/N	Factors Influencing participation	Male QS		Female QS		Overall	
		Mean	Ranking	Mean	Ranking	Mean	Ranking
1	Studied construction related course	3.34	1st	3.29	2nd	3.31	1st
2	Supplementing Spouse income	2.72	8th	3.39	1st	3.11	2nd
3	Enjoyment of daily work tasks	2.9	5th	3.00	4th	2.96	3rd
4	Offered a job or training opportunity in construction	2.98	3rd	2.73	6th	2.93	4th
5	Prestige of the career	2.79	7th	2.89	5th	2.85	5th
6	Opportunity to be a role model	2.52	9th	3.04	3rd	2.81	6th
7	Recruitment policies and procedures	3.24	2nd	2.59	8th	2.79	7th
8	Nature of the construction industry orientation	2.88	6th	2.72	7th	2.72	8th
9	Lack of alternative employment	2.91	4th	2.3	9th	2.56	9th

Source: Researcher's Survey (2019)

Further analysis was conducted on the ranking of factors driving female QS participation in the NCI in order to test the level of agreement between female and male respondents; results of T-test analysis in this respect was presented in Table 2. The results revealed that a significant level of agreement exists between female and male perceptions of the importance of the factors. This was inferred from the fact that the t-statistic (t-cal) value obtained was lower than the critical value of $t_{0.05}$ (t-tab). The t-cal value was 0.245 compared to the t-tab value of 2.306; this indicated that the difference between the parties sampled was not significant. In other words, there was agreement between the parties sampled. Furthermore, the P-value of 0.813 was higher than the acceptable threshold (level of significance - LOS) of 0.05.

Table 2: Paired Samples T-Test of Drivers of female Quantity Surveyors participation

Variables		Type of Model	Observations					Inferences
X_1	X_2		Mean Values	T_{cal}	T_{tab}	P_{value}	Significance	Remark
Male Qs	Female Qs	Paired Sample	X_1 =2.9200 X_2 = 2.8833	0.245	2.306	0.813	0.05	NSSD*

Source: Researcher's Survey (2019);

*NSSD: Not Statistically Significant Different; LOS: Level of Significance

Challenges encountered by female Quantity Surveyors in the construction industry

The challenges encountered by female QSs in the course of participation in the NCI are presented in Table 3. As a group, both males and females ranked 'Unsociable work hours (Mean = 2.59)', 'Access restriction to some location due to religio-cultural beliefs (Mean = 2.55)', and 'Denial of professional activity by colleagues due to family commitment (marriage, pregnancy, child responsibilities) (Mean = 2.52)' as 1st, 2nd, and 3rd most influential challenges encountered by female quantity surveyors. Female respondents agreed mostly with this ranking, only transposing the 2nd and 3rd ranked challenges. Male respondents however differed quite radically in their own ranking of the challenges. In the opinion of male respondents, 'Labour conditions such as extreme weather', 'Difficulty in balancing work and family commitments', and 'Access restriction to some location due to religio-cultural beliefs' deserved to be ranked as 1st, 2nd and 3rd most influential challenges respectively.

A paired sample t-test of the challenges encountered by female QSs in the NCI was also carried out to test the level of agreement between female and male respondents.

Table 3: Challenges hindering Female Quantity Surveyors participation

S/N	Challenges encountered	Male QS		Female QS		Overall	
		Mean	Ranking	Mean	Ranking	Mean	Ranking
1	Unsociable work-hours	2.10	6th	2.95	1st	2.59	1st
2	Access restriction to some location due to religio-cultural beliefs.	2.17	3rd	2.82	3rd	2.55	2nd
3	Have you been denied professional activity by your colleagues due to family commitment (marriage, pregnancy, child responsibilities)	2.00	7th	2.90	2nd	2.52	3rd
4	Labour conditions such as extreme weather	2.22	1st	2.63	6th	2.46	4th
5	Physical incapability due strenuous activity required by a job.	2.17	3rd	2.66	5th	2.45	5th
6	Not being given equal opportunities to perform as compared to male	1.97	8th	2.80	4th	2.45	6th
7	Difficulty in balancing work and family commitments	2.21	2nd	2.38	8th	2.31	7th
8	Masculine nature of the industry	2.16	5th	2.34	9th	2.26	8th
9	Have you been denied professional duties from clients due to your marital status?	1.97	8th	2.32	10th	2.17	9th
10	Sexual discrimination/ Intimidation by male counterparts	1.45	11th	2.61	7th	2.12	10th
11	Difficulty in getting accustomed to work after career break or childbirth	1.76	10th	2.13	12th	1.97	11th
12	Male subordinates refuse to cooperate	1.31	14th	2.18	11th	1.81	12th
13	Sexual harassment by male employer/superiors	1.45	11th	2.05	13th	1.80	13th
14	Sexual harassment	1.34	13th	1.85	14th	1.64	14th

Source: Researcher's Survey (2019)

The T-test analysis result, which was presented in Table 4, revealed that significant disagreement existed between male and female respondents on the challenges encountered by female quantity surveyors in the construction industry. This was inferred from the fact that the t-statistic value obtained was higher than the critical value of $t_{0.05}$, which can be either negative or positive (i.e. two tailed test). In addition, the probability of only chance differences between the variables (Pvalue) was much lower, quite within the acceptable threshold (LOS) of 0.05. The results also revealed that while males viewed the challenges faced by women QS as 'less frequent' (Mean Score = 1.93), female perceived such challenges as 'fairly frequent' (Mean Score = 3.85).

Table 4: Paired Samples T-Test of Challenges of female Quantity Surveyors participation

Variables		Type of Model	Observations					Inferences
X_1	X_2		Mean Values	T_{cal}	T_{tab}	P_{value}	LOS	Remark
Male Qs	Female Qs	Paired Sample	X_1 =1.9276 X_2 = 3.8535	-7.570	2.160	0.000	0.05	SSD*

Source; Researchers' Survey, 2019

*SSD: Statistically Significant Difference; LOS: Level of Significance

DISCUSSION OF FINDINGS

The top 3 key drivers of female quantity surveyors' participation in the NCI are (i) completion of a construction-related course i.e. quantity surveying; (ii) desire to supplement spouse's income; and (iii) enjoyment of daily work tasks. It was also found that a significant level of agreement existed between female and male respondents with respect to their perceptions of the importance of these drivers. This result differs in some respects from what has been written up in literature. While the study agreed with Arroyo *et al*. (2018) that both women and men perceive gender bias in the construction industry, it disagreed with the finding in Arroyo *et al.* (2018) that a larger portion of men compared to women think that gender bias is not an issue. This was because there was no difference in men and women's perception of factors affecting women participation in this study.

As regards the factors that hinder female participation in the NCI, the top 3 challenges encountered by female quantity surveyors are (i) Unsociable work hours; (ii) Access restriction to some locations due to relio-cultural beliefs; and (iii) Denial of professional activity by colleagues due to family commitment (marriage, pregnancy and child responsibility). These results agree with the findings of Arroyo *et al.* (2018) that women perceive their gender as a reason to not be recruited, be delayed in promotion or not having their ideas taken seriously. Gyasi (2012) also stated that more women are engaged in marginal roles like labourers and secretaries, owing to challenges such as lower educational and professional certifications possessed.

CONCLUSION AND RECOMMENDATIONS

It can be concluded from the findings of the study that the major motivational factor driving the participation of female Quantity Surveyors in the construction industry is based on the premise that they (the females) have undergone a construction-related course of study. Non-conducive work hours (unsociable work-hours) has been identified as the major challenge encountered by the female Quantity Surveyors in the Nigerian construction industry.

These findings have led to the recommendation that stakeholders within the Nigerian construction industry should intensify efforts on creating more administrative offices limited and open exclusively to Female Quantity Surveyors. This will allow female Quantity Surveyors (i) Exercise administrative skills and professional competence at both Government level (QSRBN) and professional body level (NIQS); furthermore, (ii) Women Quantity Surveyors should be given freedom to exercise and experiment new ideas. Discretion to make decision and take initiative in their assigned roles will allow other employees to tap into their stream of creativity. (iii) In order to improve the level of participation of female Quantity Surveyors, the female Quantity surveyors should be given adequate motivation in every aspect of work in the construction industry.

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Effects of Skill Gap on Labour Productivity on Construction Sites in Abuja

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Abstract

Human resources in many developing countries are of insufficient quantity and quality to encourage high rate of fiscal and infrastructural development. The manpower mostly needed in large quantity in Building construction industry globally and in Nigeria are artisans and skilled labour. This research work aimed to evaluate the effects of skill gap on labour productivity on construction site in Abuja in order to improve their productivity. To achieve this, a quantitative research was carried out via a disseminated 36 structured questionnaires to construction practitioners in Abuja. 30 questionnaires out of 36 sent out were retrieved giving a return rate of 87.71%. The data analysis was carried out descriptively using percentage analysis, mean ranking and RII of the SPSS version 20.0. The results revealed out of the relevant skills needed for construction work, technical skills are the major skill required in construction production process. Also on the effect of skill gap, the study discovered that poor workmanship has the highest effect on construction industry follow by increased in project labour cost which affect the overall budget of the project. The research recommends that necessary trainings such as apprenticeship training and on the – job should come to fore by construction firms and be made important among the other training within construction industry. Also, construction firms should ensure recruitment of workers who are highly skill technically, supervisory wise and have multi skilling. The research concluded that there exist skill gap which affects labour productivity which can be curbed with adequate implementation of the training method from the research outcome and ensuring that the major construction skills are employed from the onset.

Keywords: Effects, Skill gap, Labour, Productivity, construction firms

1.0 INTRODUCTION

The construction industry occupies a sensitive locus, as it performs a conspicuous part in the frugality of every country (Achuenu, *et al.,* 2000). All around the world is the cry for adequate skilful construction workers.

Skill gaps refer to the occurrence whereby the skill extents of workforces are inadequate to meet the obligations of their present work (McGuinness and Ortiz, 2015). Lerman (2013) also make certain that skills are the principal basis of high productive feat and profitable well-being. In the same vein Zannah *et al*. (2017), stated that the height of skilled workers' low performance has been comprehended to be a major issue which play a part in unproductive construction projects. Odediran and Babalola (2013), opined that the type of manpower mostly needed in large quantity housing construction in Nigeria and globally are artisans and labour. Okuntade (2014) observed that despite the prominence of construction skilled worker to the industry, an enormous number of them are nevertheless untrained, despite the fact that many of the construction industry globally have started making tremendous implementation of skill acquirement plan to meet with the demand change in technology presents.

For the construction industry in Nigeria to give out a cost effective and successful production outcome, the industry has to engage experience, skill operatives such as reliable, qualify and capable craftsmen. The contractor coordinates and also directs his craftsmen (operatives) which according to Dantong (2007) comprise the key labour force of the contractor. However, Dantong (2007), further observed that the problem of the construction industry is how to resolve the must for a recruitment of skilled workforce of great productivity in carrying out a streamlined successive tasks and retention of a sizable highly skilled workforce.

Despite the level of the workforce the industry is still experiencing skill gap (Bilau *et al*., 2015). Wahab (2000), observed that qualitative and assessable deficiencies in workmanship are some of the influences against the achievement of success in the Nigerian construction industry. In profiling improvement to the problem of skill gap as it relate tp productivity in the construction industry many authors have looked into it in different direction. Of such are Usman *et al*. (2012), who evaluated the training of contractor's craftsmen for productive improvement in Nigeria. Embarking on the training of construction craftsmen will go a long way in curtailing these problems in project delivery in Nigeria. Nevertheless despite this substantial research in this area their still exist the problem of skill gap in the construction industry in Nigeria. This therefore necessitates the need for this research to assess the past work on labour productivity with attention on the effect of skill gap effects of skill gap on labour productivity on construction sites in Abuja.

1.1 Aim and Objectives

This study aim at evaluating the effects of skills gap on labour productivity in the construction industry with the view to improve productivity.

To realise the aim of this study the following objectives were carried out:

1. To identify the skills required in managing the production process of building projects.
2. To determine the implications of skills gap in construction industry
3. To identify the best training methods that will optimize the productivity of construction craftsmen in the Nigeria construction industry.

1.2 Scope of the study

The scope of this research work includes the identification of major skills peculiar to building construction project, the effects of skills gap on labour productivity in the construction industry which covers craftsmen, using Abuja as the study area.

2.0 LITERATURE REVIEW

2.1 Skills Issues in the Building Sector

Alemi (2010), emphasized that Nigerian metropolises with the exclusion of the reserve of the rich and influential are regarded as poor quality structures, poor layout and streets access, lack of vital utility facilities, insufficient safety, and social services. Apparently, deficiencies exist between the skills of vocational workers and those required to meet the needs and expectations of employers in the Building sector. This can be ascribed to the declining stock of skilled construction workers and the influx of unskilled, incompetent and discontented workers who see the construction firms as a last option (ITF, 2014) .The construction industry is growing but it seems the stock of competent skilled construction workers has reduced (Odusami and Ene, 2011).

2.2 Skills Required for the Production Process

Skills required for production process are basically of two types; technical skills and advance skills (Adavbiele, 2013). Adavbiele (2013) created a protracted list of technical skills needs in the Nigerian Building sector. The skills are: Building drawing skills, Surveying, landscaping and site preparation skills, Foundation skills, Ability to use machines for construction, Ability to use hand tools for practical work, Brick and block Laying skills, Roofing skills, Masonry skills in building Concreting and reinforcement skills, Carpentry and Joinery skills, Final Finishes skills and Plumbing skills. Sherekar and Tatikonda (2016) identified the major

categories of skilled workers in the construction industry as; mason, painter, steel fitter and plasterer. Adewale *et al.* (2014) listed categories of skilled workers which include; carpenter, bricklayer, painter, iron bender and plumber. Oseghale *et al.*, (2015) asserted that, frequent used skilled workers in the construction industry include; carpenters, bricklayers, bar bender, plumbers and painters where their services are required most in construction projects. Uchitelle (2009) identified common skilled workers as electricians, plumbers, painters, carpenters and bricklayers, bar benders, tile fixers, plant operators, welders, mechanics, and steel fixers. Offei-Nyako *et al.* (2014) stressed that, skilled workers vary from mason, carpenter, tile worker, steel worker, painter, electrician and plumber.

In addition, there are also advance skills that can greatly impact the construction industry; advance skill such as technical skills. multi-skilling, supervisory skills, team-working skills, health and safety regulation compliance, customer relations are still on the reduced level and should be maximally cultivated for better productivity in the industry.

2.3 Implication of Skill Gap in the Building Sector

Bilau *et al*. (2015) opined that skills shortage has influence on project performance and Oke *et al*. (2019), stated that skill gap has impact on workmanship, upsurge in construction costs, and reduced budget performance. Common indicators of Skills issues are poor workmanship and Building Failure (Oke *et al*., 2019). Nigerian cities with the exception of the enclave of the rich and powerful are characterised by poor quality structures, poor layout and streets access, lack of essential utility services, inadequate security, and social services (Alemika, 2010).

2.4 Skill Training Methods of Optimizing the Productivity of Construction Craftsmen

Dermol and Cater (2013) who discovered that training can have a momentous and positive impact in labour output in the construction industry. Kazaz, Ekrem, and (Sardar, 2008) observed that the best which can be applied to get a productivity boom by construction management is the selection of the right people who have been duly groomed through trainings to control certain functions.

However, (Ying 2009) found that one of the greatest obstacles to implementing a quality training program for any organization is lack of funding. However, this come with the implication of contractors being scared of including the cost of training in their bid package for fear of upshot in the contact sum which can place them at a disadvantage with their competitors. Trade associations cannot establish or implement training until they have a commitment from contractors to support and pay for training.

3.0 RESEARCH METHODOLOGY

Quantitative approach was used for this study to gather information from the construction practitioners practicing in Abuja. The specimen unit of this study is the construction firms who have ongoing project in Abuja. The sample size of 36 from a population size of 40 was obtained using Yamane's formula.

$$n = \frac{N}{1+N\,(e)^2} \text{ ---------- (1)}$$

where; n is the sample size, N is the population size, and e is the level of precision at 95% confidence level with P=0.05. The essential information for the study was gotten through dissemination of well-structured questionnaires used as data collection instrument. Questionnaires were self-administered to construction firms in Abuja. However, 30 completed questionnaires were returned. Hogg *et al*. (2015) determined a sample size of 30 from a random

sampling as adequate stating that the smaller the variance, the smaller is the sample size needed to achieve a given degree of accuracy.

The data collected was analysed using descriptive analysis; frequencies, percentage analysis, Mean rank and Relative Importance Index (RII) with the aid of SPSS version 20.0. Data presentation was in form of tables.

Respondents opinions were obtained and they were ranked from the positive rating to the negative rating for example the respondent were told to indicate the training mechanisms use in their organisation using a likert scale of 1-5. Where 1 = not at all and 5 = much implemented. Respondents opinions were obtained and they were ranked from the positive rating to the negative rating for example the respondent were told to indicate the effects of skill gap on project using a 5-Likert point, where 1 = strongly disagree and 5 = strongly agree. In using the ranking method, the relative importance index (RII) were obtained using the formula, RII = ΣW/ A x N, where W is weight, N is number of respondents and A is highest score.

4.0 RESULTS AND DISCUSSION

Table 1: Qualification of respondent

Qualification of respondents	Percentage	Frequency	Year in service in the organisation	Percentage	Frequency
HND	10.0	3	1-5	63.3	19
B.SC/B.TECH/B.ENG	60.0	18	6-10	16.7	5
PGD/MASTER	20.0	6	11-15	16.7	5
DOCTORATE	10.0	3	16-20	3.3	1
Total	100.0	30	Total	100.0	30

Table 1 shows the qualification of respondents. Of all the thirty (30) respondents, the majority of respondents had (B.sc/B.Tech/B.Eng) making up 60%, followed by PGD/Master with 20%, while HND and Doctorate both have an equal percentage of 10%. This shows that the entire respondents are qualified academically and they have the understanding of the study been carried out. The respondent's years of experience in their Organisation are discussed as followed of the thirty (30) questionnaires returned, nineteen (19) of the respondents have experiences of 1-5 years and these accounted for the most dominant group with 63.3%. The second group 6-10 and 11-15 are having 16.7%, while the last group 16-20 represent 3.3%.

Table 2: Designation of respondents

Designation of respondent in the establishment	Frequency	Percentage
Builder	6	20.0
Architect	4	13.3
Chief executive/managing director	2	6.7
project manager	2	6.7
Cost Adviser	4	13.3
Engineer	11	36.7
Project officer	1	3.3
Total	30	100.0

The respondents are of different designations, of the thirty respondents, 36.7% are Engineers in their organisations, 20% are Builders in their organisation, Architects and Cost Adviser have 13.3% to represent their organisations, while Chief executive/Managing Directors, Project manager are of equal percentage of 6.7%, and Project officer with one (1) frequency which represent 3.3%.

Table 3: Skills employed in construction process

S/N	Skills employed in construction production process	Mean rank	Rank
1	Technical skills	0.83	1
2	Supervisory skills	0.63	2
3	Multi- skilling	0.27	5
4	Team- working skills	0.47	3
5	Health and Safety	0.03	8
6	Regulation and compliance	0.23	6
7	Customer relations	0.31	4
8	Others	0.13	7

Table 3 shows that the major skill employed in construction production process is technical skills (0.83) and this was followed by supervisory skills with 6.3 and the least on the rank is health and safety skill.

From Table 4 it was discovered using Relative importance index, Poor workmanship is the major effects of skills gap on construction project with 0.713, closely followed by increased project labour cost with 0.706 and the least rank is reduced quality training/meeting.

Table 4: Implication of skill gap on construction project

S/N	Item	1	2	3	4	5	Scores	RII	Rank
1	Constructability problems	8	3	4	8	7	93	0.620	5
2	Poor workmanship	5	5	2	4	14	107	0.713	1
3	Rework	5	5	5	11	4	94	0.626	4
4	Reduced budget performance	6	2	7	5	10	101	0.673	3
5	Improved schedule performance	12	2	4	5	7	83	0.553	8
6	Reduced conformance to specification	6	5	5	8	6	93	0.620	5
7	Reduced time needed to rectify defects	10	5	2	7	6	84	0.560	7
8	Increased project labour cost	4	3	5	9	9	106	0.706	2
9	Reduced quality training/meeting	11	4	5	5	5	79	0.526	10
10	Increased profit rate of project	10	3	6	6	5	83	0.553	8

The result shows that poor workmanship is the direct effects of Skill Gap on any construction project because the skilled required for a particular task matters a lot on any project success which can also lead to rework and causes increase in project labour cost. This confirmed the findings of Bilau *et al*. (2015) who opined that skills shortage has influence on project performance and Oke *et al*. (2019), they stated that skill gap has impact on workmanship, upsurge in construction costs, and reduced budget performance.

Using mean ranking, Table 5 shows that the best method of training craftsmen is on the job training which is more practical and effective with mean rank of 0.80, followed by Apprenticeship training 0.77 and the least training method is vestibule school 0.07.

Table 5: Methods of training for craftsmen

S/N	Methods of training for craftsmen	Mean rank	Rank
1	Class room training	0.30	7
2	Trade Group training	0.50	5
3	Apprenticeship training	0.77	2
4	On the- job training	0.80	1
5	Crafts apprenticeship courses	0.57	4
6	Vestibule school	0.07	10
7	Conference or Discussion Method	0.43	6
8	Sink and Swim method	0.17	8
9	Time release training	0.13	9
10	Apprenticeship programmes	0.67	3

This is in consonant with Dermol and Cater (2013,) who discovered that training can have a momentous and positive impact in labour output in the construction industry.

SUMMARRY OF FINDINGS

Based on the results from the analysis of the data collected via the questionnaires the findings were made:

i. Skill gap still exist in construction industry and the major implication on construction industry is poor workmanship from construction craftsmen which had the highest RII ranking of 0.713 among the ten (10) listed effects of skill gap on labour productivity.
ii. Technical skill was identified as the major skill required in building production among the seven (7) listed skills employed in construction production process for this study.
iii. While supervisory skills is important to put in check the activities of the craftsmen on the site for best performance and effective productivity.
iv. The best training method identify to curb skill gap is on- the job training which had 0.8 mean rank followed by apprenticeship training for the craftsmen.

CONCLUSION

The challenge of skills gap in the construction industry is not peculiar to Nigeria. But the absence of reliable data on the supply and demand for skills is the case and is of utmost concern to stakeholders in the sector across the country. Skills gap needs to be address by every parties involves in construction starting from the Government, construction firms, professional bodies, contractors and the craftsmen to boost productivity and this can be realised by adequate training.

RECOMMENDATIONS

1. Necessary training such as apprenticeship training and On the – job should come to fore by construction firms and be made important among the other training within construction industry.
2. Construction firms should ensure recruitment of workers who are highly skill technically, who have supervisory skill and also multi skilling
3. Management should ensure that they put in place a system that can check and also blocks every avenue that results into poor workmanship, increased project labour cost and Reduced budget performance
4. Relevant stakeholders in the built environment should come together and form policies that will enhance the development of skill for craftsmen.
5. All other factors that causes skills gap as identify in this study and related literature should be look into and properly address.

This study suggested the following areas, for further research, Skills Gap Analysis in the Construction Industry in Nigeria, The Impact of Best Training Methods for Craftsmen in the Construction Industry in Nigeria.

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Evaluation of Cost Management in Building Maintenance by Contractors

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Abstract:

Cost overrun have been identified as one of the major problem in construction especially in maintenance and remedial works. Identifying factors that influence cost in building is prerequisite to avoiding cost overrun. However, these factors were not determine by previous researches. Against this backdrop, this paper aims at evaluating method of cost management in building maintenance with a view of enhancing cost saving when carrying out building maintenance. The paper adopted quantitative research method. The population of the study comprises of 25 construction companies carrying out different maintenance works in ABU Zaria. A total of 50 questionnaires were sent to contractors, 46 were returned complete and used for the analysis. Data was analysed using descriptive statistics and result was presented in charts and tables. The result revels changes in plan and drawings (mean=4.37), delivery of materials to site on time (Mean= 4.11) are the major factors that influence cost in building maintenance. The study further revels that setting of cost limits through budget (Mean=4.09) and use of economic criteria to determine priority in building maintenance are the major ways of avoiding cost overrun in building maintenance. The study recommends detail design and comprehensive investigation to be carried out before proceeding with maintenance work as a way of avoiding cost overrun.

Keywords: Building, Cost, Contractor, Control, Maintenance, Overrun.

Introduction

The act of maintenance is necessary for every kind of building, whether new or old, small or large. This is because for every building to perform optimally in fulfilling owners or residents requirements, its fabric and components must be assessed, if found performing below acceptable standard; they must be repaired, and if there is desire for better performance; they must be upgraded (Le, Domingo, Rasheed, and Park, 2018). British Standard 3811 (1993) defines building maintenance as a work carried out on existing buildings in order to keep, restore or improve the building, its parts or components, its services or the surrounding of the building to its original level or not to fall below a minimum acceptable level. Seeley (1986) believes building maintenance could be as simple as changing door handles or as complex changing roof structure. Consequently, building maintenance is paramount if buildings are to serve their intended purpose.

Building maintenance if properly carried out extend the life of buildings (Son and Yuen, 1993). The quality of building maintenance in a country is a significant indicator of strength of the country's economy (Son and Yuen, 1993). Consequently,

Inevitably, the process of carrying out building maintenance like other aspect of construction requires resources. These resources includes materials, labour and machines, which all have cost. The amount of resources required for maintenance depends on the complexity or nature of repairs. Despite benefits of maintenance to building, the amount of resources required limit the extent to which owners will maintain their structures (Le et al., 2018). Le at al (2018) further asserts that it is often cost that determine the quality of maintenance work. Consequently, the cost of carrying out building maintenance is very vital to the success of the maintenance.

Cost itself is a subjective term. An economist may view cost as an alternative forgone. Hanson (2004) see cost as the price paid to every factor of production to produce an item. Consequently, the cost of carrying out building maintenance will include every price incurred from inception

to completion of the work. It is worthy of note that the cost of maintenance all add up to the building whole life cost. The long term cost of a building affect client decision on the type of building to construct. Consequently, it is important to have a mechanism that will ensure cost of carrying out building maintenance are within acceptable limits.

Controlling maintenance cost ensures that investment in buildings are within budget. Cost control is the act of ensuring that buildings are maintained at a reasonable cost within a specified budget (Seeley, 1986). Cost control need to be considered starting at budget preparation, operational phase and at post budget implementation phase where the performance of the budget is evaluated.

Anyanwu (2013) see cost control as an integral of cost management. Cost management is a process of utilizing the construction cost related resources of the construction to sub-designated objectives. This definition see cost control as a process of getting things done through working with people and using other resources.

LITERATURE

Straub (2018) identify two broad classification of maintenance; preventive and corrective. Preventive maintenance is time based maintenance carried out at a known intervals or at other prescribed criteria. Preventive maintenance is intended to reduce the likelihood of an item not meeting an acceptable condition. On the other hand, corrective maintenance is any maintenance activity which is required to correct a failure that has occurred or is in the process of occurring. Other forms of maintenance such as schedule or unscheduled all come under the broad classification.

Cost control in maintenance is similar to that of conventional construction. This is because they both involve monitoring and controlling (Anyanwu, 2013). Monitoring is finding out the state of affairs as they progress. Monitoring has to do with keeping an eye on the progress against established benchmark. . It is an important tool for control but does not substitute control (Anyanwu, 2013). It is a tool needed for an effective control. Control is taking necessary steps at ensuring an activity remain according to plan. . It is a positive and active operation, which its success can be judged by subsequent events. Taking decisions in the exercise of control demands sound information, which is the result of good monitoring.

RESEARCH PROBLEM

Otim *et al* (2007) acknowledges that project managers find difficulty in controlling costs on their construction sites due to a number of problems that often lead to time and cost overruns. Otim *et al* (2007) subsequently investigate method of cost control in construction projects. Similarly, Anyanwu (2013) study the variables that affect cost in a construction project.

However, the factors that influence contractors cost when carrying out building maintenance where found not to be covered by previous researches. Giving the position of a contractor in carrying out any form of construction, this paper aim at assessing the relevant cost control measures that contractors can take to ensure successful completion of building maintenance projects.

METHODOLOGY

Methodology been a systematic, theoretical analysis of the methods applied to a field of

study comprises of both the theoretical analysis of the body of methods and principles associated with (Igwenagu, 2016). Kumar (2011) research methodology to be either qualitative, quantitative or mixed. This paper target at finding how contractor mange cost in building maintenance. It is interested in finding individual response to a how question. Consequently, the methodology of the study is quantitative in nature.

The population of the study comprises of a total of 25 contractors carrying out maintenance work in ABU Zaria. ABU Zaria was selected for the study considering high number of maintenance work taking place which are all under one institution.

The study consider all the contractors as its sample size. Therefore it can be considered as a census survey.

The data collection instrument for the research is a pair of two (2) questionnaire. Each pair of questionnaire was send to a contractor. A senior level manager is required to fill the first questionnaire, while a manager at operation level was required to fill the second questionnaire. This is to aid in providing quality information.

Fifty (50) questionnaires were sent to 25 contractors. 46 questionnaires were fill, returned and consider fit for analysis.

Questionnaires were analysed with the aid of the statistical package for social sciences. Using descriptive statistics, the result were presented in tables and charts.

RESULTS AND DISCUSSION

Background of Respondents

This paper study methods of controlling building maintenance cost by contractors. Figure 1 presents Age of companies

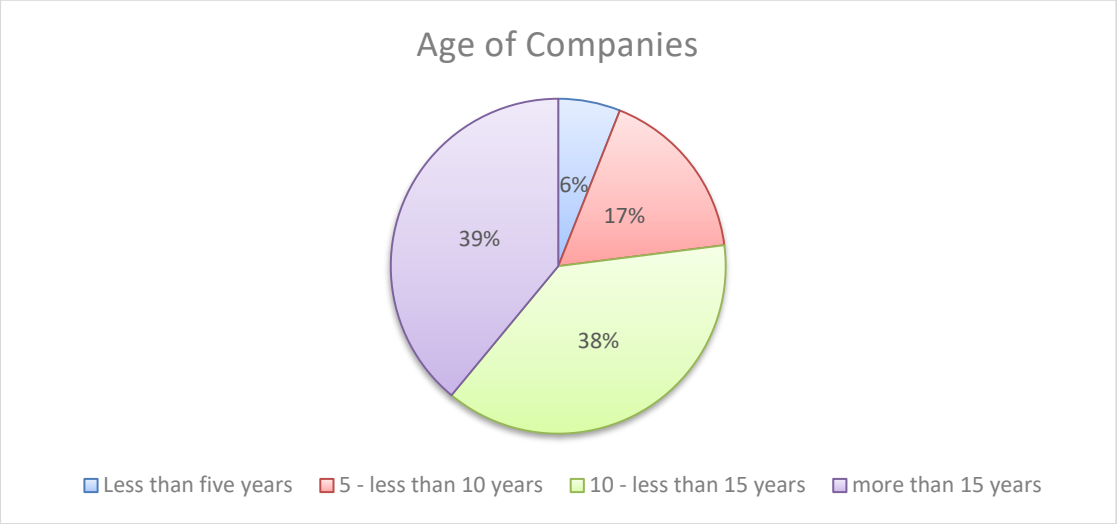

Figure 1: Contractors years of experience in building maintenance.

Source: Field Survey.

The result in figure 1 shows that most (55 %) of the companies have experience of building maintenance for more than 10 years. This shows that the companies has necessary experience to understand the implication of cost in building maintenance.

Factors That Influence Cost in Building Maintenance

The cost of carrying out building maintenance were attributed to certain factors. Respondents were asked to rank the degree to which they think each of the identified factors can influence cost when carrying out building maintenance. The result was collated and presented in Table1.

Table 1 present result on the response of respondents on the factors that influence cost the most when carrying out building maintenance. The result indicates that the factors that influence cost the most when carrying out building maintenance are changes in plan and design with a mean of 4.11, lack of planning on how to carry out the job with a mean of 4.04 and errors when carrying out the work base on wrongly supplied data with a mean of 3.91

This result support the findings of Anyanwu (2013) who observes that the cost of construction may be affected by frequent changes in designs and drawings among other factors

Table 1: Factors That Influence cost in building maintenance.

S/N	Factors	Frequency					Response (N)	RII	Mean	Rank
		5	4	3	2	1				
1	Changes of plan and drawings	13	27	5	0	1	46	0.82	4.11	1
2	Lack of planning and coordinating or less emphasis planning	9	30	7	0	0	46	0.81	4.04	2
3	Errors in carrying out work which are based on incorrect written data supplied by the builder or engineer	10	24	10	2	0	46	0.78	3.91	3
4	Mistake during construction or defective work	9	25	9	2	1	46	0.77	3.85	4
5	maintenance requirement of each buildings	5	26	12	3	0	46	0.74	3.72	5
6	past budgetary and records/provision	7	23	11	5	0	46	0.74	3.7	6
7	complexity of construction	5	20	16	4	1	46	0.7	3.52	7

Source: Field Survey, 2018.

Method of Cost Control in Building Maintenance

Otim et al.(2007) while studying building maintenance in Uganda identified that certain steps can be taken to control cost when carrying out building maintenance. The factors that can be used to control cost were identified from literature. Respondents were asked to rank how likely they agreed each of the identified factor can serve as a cost control measure. The result was collated and presented in Table2.

Result in Table 2 present respondents responses on method of controlling cost in building maintenance. The result indicates that respondents agree that all the identified methods can be

used to control cost when carrying out building maintenance. However, using staff that have experience in carrying out maintenance, delivering materials on site in time and setting cost limits were rank as the most significant ways of controlling cost when carrying out building maintenance.

Table 2. Methods of Cost Control in Building Maintenance

S/No	Methods of cost control	Frequency Responses					Total Responses (N)	RII	Mean	Rank
		5	4	3	2	1				
1	setting of cost limits in a project	16	20	8	2	0	46	0.82	4.09	4
2	use of economic criteria to determine priority in building maintenance work in your department	17	17	5	7	0	46	0.79	3.96	6
3	delivery of materials in time on site	25	13	8	0	0	46	0.87	4.37	1
4	using overtime of site labour	10	21	7	7	1	46	0.74	3.70	9
5	good maintenance of construction plant and equipment	21	12	5	5	0	46	0.77	3.87	8
6	providing sufficient data collection at design phase	18	21	6	1	0	46	0.84	4.22	3
7	proper and accurate estimate of original cost	17	18	6	5	0	46	0.80	4.02	5
8	appropriate/experienced staff/workers	25	16	2	3	0	46	0.87	4.37	1
9	different consultant for design supervision and contract administration	5	21	12	5	3	46	0.69	3.44	10
10.	Mutual relationship among consultant contractor and the client	15	19	5	7	0	46	0.78	3.91	7

This result also supports the findings of Anyanwu (2013) and Otim et al (2007) who both identified that setting cost limits and experience of staff in carrying out maintenance are important ways of keeping the cost of maintenance within budget.

CONCLUSION

Base on the result, this paper conclude that changes to plans and drawings, giving less emphasis to planning maintenance work and written errors supplied by engineers or designers are the major factors that influence cost of building maintenance.

In order to control the cost of building maintenance, the paper conclude that contractors should employ only staff that have relevant experience when carrying out maintenance. Contractors should also deliver materials to site on time and set cost limits before the commencement of any maintenance work.

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Effect of Cash Flow on Contractors' Performance in Building Construction Projects in Niger State

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Abstract:

Cash flow is the lifeblood of the construction industry; cash is the most important resource for a construction company, because more companies become financially ruined due to lack of fund for supporting their day-to-day activities. However, securing sufficient cash flow at all phases of construction project execution are the most challenging and chronic issues facing contractors. This implies that a study of the effect of cash flow on contractors' performance is still a gap which needs to be filled in order to link cash flow management with contractor' performance. Primary data were obtained from the Niger State Ministry of Works, Niger State Housing Corporation and Physical Planning and Development Unit, Federal University of Technology, Minna through a well-structured questionnaire distributed to 58 respondents with a response rate of 89.66%. Relative Importance Index (RII) and Mean Item Score (MIS) were employed for the analysis of data. The study found that improper planning and management is the most important factor affecting contractors' cash flow (RII = 0.91). Contractor experience was found to be the most important factor affecting contractors' performance (RII = 0.95). Timely completion of projects was discovered as the most significant effect of cash flow on contractors' performance (MIS = 4.83). Having appropriate planning was found to be the most effective strategy for improving contractors' performance. It was thus recommended that contractors' should always have appropriate plan and understand people's requirements and needs which will help and go a long way to improve their performance.

Keywords: Building, Cash flow, Construction projects, Contractors' performance.

INTRODUCTION

Construction projects such as buildings, highways, bridges, underground utilities, drainage facilities and industrial projects, among others are known for their high risk, complexity and uncertainty, particularly, at the cost estimate phase of such projects where the amount of project's information is very limited. As such contractors cannot survive in the competitive construction industry without effective cash flow management (Tarek and Yaqiong, 2014).

Securing sufficient cash flow at all phases of construction project execution is the most challenging and chronic issue facing contractors (Khalil *et al.*, 2012). Sufficient cash flow is absolutely necessary for three objectives; to pay for overhead, labour, and material expenses; to execute construction activities according to schedule; and to reduce financing liabilities (Khalil *et al.*, 2012). Studies have identified that lack of liquidity represents a major problem that leads to the failure of construction projects and bankruptcy of construction companies (El-Kholy, 2014). Tarek and Yaqiong (2014) stated that it is impossible for a contractor to survive in the construction industry without proper cash flow management, as is the case for all industries as well as individual entities.

In addition, many authors have studied the causes of failure in construction industry (James, Woung and Thomas, 2010). Despite the considerable amount of literature existing on the problem of company failure due to poor management of cash flow in the construction industry and other erratic industries, challenges on implementing efficient cash flow continue to plague the construction industry (Ogawa, 2015). However, it can be understood that previous studies concentrated mainly on identification of the parameters for measuring contractors' performance and construction project performance. This implies that a study of the effect of cash flow on contractors' performance is still a gap which needs to be filled in order to link

cash flow management with contractor' performance. In view of this, the study focused on investigating the effect of cash flow on contractors' performance. In order to achieve the aim, the study identified and examined the factors affecting contractors' cash flow; examined the factors that affect contractors' performance; established the effect of factors affecting contractors' cash flow on contractor' performance and suggested strategies for improving contractors' performance.

LITERATURE REVIEW

This section gives a review of relevant literature to the theme of the study. In the context of this study, "Cash Flow on Contractors' Performance" means how the circulation of cash affects contractors' performance in terms of Cost, Time and Quality.

Concept of Cash Flow

In very general terms, 'Cash Flow' is the movement of income into and expenditure out of a business (or other entity) over time (Brook, 2016). If more money is coming into the business than is going out of it, cash flow is said to be 'positive'. If more money is going out, this is negative cash flow (Brook, 2016). In construction, however, the term 'Cash Flow' typically refers to an analysis of when costs will be incurred and how much they will amount to during the life of a project (Brook, 2016).

The Importance of Cash Flow in Construction

The importance of steady fund income is crucial in construction projects; Cash flow can procure material, pay salaries, fund new projects, and finance other functions of the companies' day to day operations (Artan, 2018). Cash flow is also an issue for the construction supply chain and is a common reason for contractors and sub-contractors becoming insolvent, this can be extremely harmful for a project in terms of time and money (Artan, 2018). Companies themselves may be marginally profitable, but if there is not enough positive cash flow, a project might start failing because of the lack of consistent funds throughout the life of the project, therefore, Contractors must ensure that a payment schedule is agreed upon with the Owner for reliable cash flow projections (Artan, 2018).

Factors Affecting Contractors' Cash Flow

Tarek and Yaqiong (2014) have reported several factors that affect contractors' cash flow. These include: Change of progress payment duration, Change of progress payment condition, retention percent, Delay in releasing retention, Loan repayment, Payments of material (before/after arrival), Over work measurement, Under work measurement, Change of labor and staff wages, Bank interest, Delay of making payments, Failure of sub-contractor, Poor design, Mistakes in executing the work, Lack of adequate insurance, Replacement of defective work, Project delayed, Material and equipment shortages, Lack of skilled labor, Improper planning and management, Contractor/owner disputes, Weather condition, Number of claims, Inability to manage change orders.

In a study conducted by Shalini (2015), it was reported that there are various factors which lead to cash flow problems. Some of the major problems according to Shalini (2015) include: Labor-intensive work, Payments to suppliers and subcontractors, Retainage, Slow paying customers, slow billing and unplanned cash expenditures.

In construction, more than 50 percent of project expenses are spent on materials, particularly for construction projects (Tarek and Yaqiong, 2014), with such an important proportion, it

makes project cash outflow very sensitive to material cost fluctuation. It is reported that the usual delay of receiving payments is (30-45) days, which will greatly affect contractor's cash outflow (Tarek and Yaqiong, 2014).

Factors Affecting Contractors' Performance

The issue of shortening construction time, reducing cost and improving production performance has engaged both practitioners and researchers for a long time; the studies include motivation and productivity investigation as well as the analysis of planning and scheduling technique (Lee *et al.*, 2014). The contractors' satisfaction with the employer and consultants was tested with regard to overall performance, the quality of the tender documents and specifications, efficiency, openness and transparency of the contract procurement and the management of variation orders and claims (Lee *et al.,* 2014).

Raid and Yerevan (2018) discovered that a lot of factors influence the contractors' performance in the execution of construction projects. Among these strong factors that are commonly reported in the construction sources are: inappropriate management of time, contractors poor experience, injured workers, customers vacillations, repeated change-orders, imprecise estimation, insufficient planning and preparations, scheduling which is not regular, missing materials, non- payment of workers' wages, shortage of new equipment and technology, price fluctuations, labors scarcity, projects complexity, regulatory inadequacies, risk mismanagement, waste and unsuitable materials etc. Those factors are enlarged with negligible usage of construction projects management software and non-existence of all kinds' construction equipment's. The study of Raid and Yerevan (2018) revealed a variety of factors affecting contractors' performance. The factors are classified as: Contractors related factors, cost factor, time factor, quality factor and external factor.

Effect of Cash Flow on Contractors' Performance

Cash flow problems can be controlled if they are identified and addressed early. If ignored, they can result in increased interest expense, increased investment of owners' capital, reduced credit ratings, inability to take advantage of new opportunities and lastly, failure of the business (Nnadi *et al.*, 2017). Many companies delayed to engage in cash flow planning under the popular misconception that meaningful cash flow forecasts aren't possible, although it's not an exact science, proper cash flow planning can help a business make accurate decisions regarding budgeting, capital expenditures, financing, compensation and growth (Nnadi e*t al.*, 2017).

Nnadi e*t al.* (2017) had pointed out some effect of cash flow on contractors' performance which includes: Timely completion of projects, increase contractor profitability, regular payment for plant higher and acquisition, quality Project delivery, regular and prompt order of materials and reduction in the buying on credit by contractor. In another related study conducted by Ogunde, Odje, Gbemisola, Kunle, Olayinka, Sakariyau, Esoeohe, and Hezekiah (2017),, effects of cash flow on contractors' performance were revealed to be; Total abandonment, disputes, time overrun, cost overrun, arbitration, litigation, poor quality of end product, loss of productivity and efficiency, damage company reputation.

Strategies for Improving Contractors' Performance

Olanipekun *et al.* (2017) depicted the need for improvement in productivity/project delivery through the use of performance improvement measures. However, if the performance of Nigerian contractors in project must be improved, it is appropriate to seek for ways and factors to improve their performance in project execution. According to Babalola, Oluwatuyi,

Akinloye and Aiyewalehinmi (2015), the factors contributing to improving the performance of contractors' in a construction projects was revealed, some of which are: Contractors progress payment on time, minimize change orders during construction to avoid delays, not bound to award the contract to the lowest bidder, but only to the proven contractor with the resource and skill, project team leader must be committed to his responsibilities and monitor the project progress closely especially on cost, time and quality.

Olanipekun *et al.* (2017) further established possible ways for improving contractors' performance in building construction projects which includes; having appropriate planning, good leadership, good communication, stakeholder relationship, taking accountability, timely documentation, comprehensive analysis, control and administrative system, understanding peoples requirements and needs, effective contractors and workers relationship, serviceability, employee empowerment, existence of key personnel, reliability, minimizing variation, conformance, hassle free building solution, less paper work.

The basis for contractors' performance according to Olanipekun *et al.* (2017) are that the project is completed on time, to the estimated budget, in the quality required, meets clients` satisfactions and needs, has happy stakeholders, exceed expectations, meet profits/fee goals, satisfy all requirements of stakeholders and is completed safely, have no legal claims, minimizes an exasperated feeling of annoyance and have no conflict. This study also reveals that criteria such as risk, conflict, and safety though usually excluded and deliver need to be taken into account.

RESEARCH METHODOLOGY

The structured questionnaires employed to gather information for the study was designed using the five-point Likert's Scale format. RII and MIS were employed to analyse the data collected in order to achieve the research objectives. The use of RII and MIS for the analysis of data in this study is based on the formula depicted in Equation 3.1 and 3.2.

$$\text{RII} = \frac{\Sigma W}{A\ X\ N} \tag{3.1}$$

Where;

Σ = Summation, W = the weights of every one of the factors given by respondents and it was in the range of (1 - 5), (A=5) the largest value of weight (i.e Highest factor) and finally N refers to the Total number respondents.

$$\text{MIS} = \frac{\Sigma W}{N} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \tag{3.2}$$

Where: Σ = Summation, W = Weight, and N = Total number respondents

The decision rule employed for the RII and MIS analysis is summarized in Table 1.

Table 1: Decision Rule for Data Analysis

SCALE	Cut-Off Point		Interpretation			
	RII	MIS	Frequency of Occurrence	Level of Importance	Level of Significance	Level of Effectiveness
5	0.81 - 1.00	4.51 - 5.00	Very Often	Very Important	Very Significant	Very Effective
4	0.61 - 0.80	3.51 - 4.50	Often	Important	Significant	Effective
3	0.41 - 0.60	2.51 - 3.50	Fairly Often	Fairly Important	Fairly Significant	Fairly Effective
2	0.21 - 0.40	1.51 - 2.50	Less Often	Less Important	Less Significant	Less Effective
1	0.00 - 0.20	1.00 - 1.50	Rarely	Least Important	Least Significant	Least Effective

Source: Adapted and Modified from Shittu et al. (2015)

RESULTS AND DISCUSSION

This section gives a presentation of the results from data analysis. The discussion and summary of findings in relation to literature findings was also done in the section.

Results on Factors Affecting Contractors' Cash Flow

This section presents and discusses the RII results of the factors affecting contractors' cash flow of which 24 factors were identified. The RII results are presented in Table 2.

It was revealed in Table 2 that improper planning and management is very important factor affecting the contractors' cash flow (RII = 0.91), other factors affecting contractors' cash flow are important (RII = 0.61 – 0.80) and (RII = 0.58 – 0.60) are fairly important factors. On the average, factor affecting the contractors' cash flow is important (RII = 0.72). Therefore, RII observed ranges from 0.58 – 0.91 with an average of 0.72. This implies that the factors affecting contractors' cash flow is up to an extent of 14.40% on a five-point scale. This finding is in line with the findings of Tarek and Yaqiong, (2014) where results show that the most significant factors are: poor planning, payment duration change of progress payment, financial position of the contractor, and project delays

Table 2: RII Ranking on Factors Affecting Contractors' Cash flow

S/No.	Factors Affecting Contractors' Cash flow	RII	Rank	Decision
1	Improper planning and management	0.91	1st	Very Important
2	Poor design	0.82	2nd	Very Important
3	Failure of sub-contractor	0.82	2nd	Very Important
4	Lack of skilled labour	0.8	4th	Important
5	Delay of making payments	0.79	5th	Important
6	Replacement of defective work	0.76	6th	Important
7	Change of progress payment duration	0.75	7th	Important
8	Project delayed	0.75	7th	Important
9	Contractor/owner disputes	0.75	7th	Important
10	Change of progress payment condition	0.74	10th	Important
11	Mistakes in executing the work	0.73	11th	Important
12	Weather condition	0.73	11th	Important
13	Number of claims	0.72	13th	Important
14	Under work measurement	0.7	14th	Important
15	Change of labour and staff wages	0.7	14th	Important
16	Delay in releasing retention	0.68	16th	Important
17	Inability to manage change orders	0.67	17th	Important
18	Over work measurement	0.65	18th	Important
19	Payments of material (before/after arrival)	0.63	19th	Important
20	Lack of adequate insurance	0.62	20th	Important
21	Material and equipment shortages	0.62	20th	Important
22	Loan repayment	0.61	22nd	Important
23	Large retention percent	0.6	23rd	Fairly Important
24	Bank interest	0.58	24th	Fairly Important
	Average	0.72		Important

Source: Researcher's Data Analysis (2019)

Results on Factors Affecting Contractors' Performance

This section examines the factors affecting contractors' performance. This is done by categorizing the factors into 5 related factors which include: contractor related factor; cost

related factor; time related factor; quality related factor and external related factor. These was ranked using RII in order of importance. Tables 3 give summaries of the results of the factors affecting contractors' performance.

Table 3 revealed that the contractors' related factors affecting contractor' performance are very important as Contractor experience (RII = 0.95) and Cash flow of project (RII = 0.90) was ranked highest. Other factors ranges between 0.69 and 0.80 were important. On the average, contractors' related factors affecting contractor' performance is important (average RII = 0.77).

Table 3: RII Ranking on Factors Affecting Contractors' Performance

S/No.	Factors	RII	Rank	Decision
1	Contractors' Related Factors			
a	Contractor experience	0.95	1st	Very Important
b	Cash flow of project	0.9	2nd	Very Important
c	Leadership style	0.8	3rd	Important
d	Project team leaders commitment to meet cost, time and quality	0.79	4th	Important
e	Size of labor	0.73	5th	Important
f	Budget progress monitoring	0.73	5th	Important
g	Site managers abilities	0.72	7th	Important
h	Project team leader adaptability to change in the project plan	0.7	8th	Important
i	Unavailability of modern equipment	0.7	8th	Important
j	Motivating skills of the project team leaders	0.69	10th	Important
	Average	0.77		Important
2	Cost Related Factors			
a	Proper planning and scheduling of works	0.93	1st	Very Important
b	Reworks	0.87	2nd	Very Important
c	Escalation of material price	0.84	3rd	Very Important
d	Accurate and reliable budget estimate	0.74	4th	Important
e	Excessive variation orders	0.74	4th	Important
	Average	0.82		Very Important
3	Time Related Factors			
a	Timely decision making	0.9	1st	Very Important
b	Coordination of contractors work in a timely manner	0.86	2nd	Very Important
c	Unavailability of resources	0.86	2nd	Very Important
d	Average delay in regular payment	0.77	4th	Important
e	Site preparation time	0.75	5th	Important
	Average	0.83		Very Important
4	Quality Related Factors			
a	Design team experience	0.97	1st	Very Important
b	Excessive errors or omission	0.84	2nd	Very Important
c	Delay in producing design document	0.83	3rd	Very Important
d	Adequate material test records	0.71	4th	Important
e	Adequate service test records	0.63	5th	Important
	Average	0.79		Very Important
5	External Related Factors			
a	Government policy (political influence from higher authority)	0.91	1st	Very Important
b	Weather conditions	0.81	2nd	Very Important
c	Physical conditions	0.79	3rd	Important
d	Economic influence (economic climate)	0.79	3rd	Important
e	Level of technological advancement	0.67	5th	Important
	Average	0.79		Important

Source: Researcher's Data Analysis (2019)

Cost related factors affecting contractor' performance are very important in proper planning and scheduling of works; Reworks; Escalation of material price (RII = 0.84, 0.87 and 0.93)

respectively. And other factors were important (RII = 0.74). On the average, cost related factor affecting contractors' performance was very important (average RII = 0.82).

Time related factors affecting contractor' performance are very important in timely decision making; coordination of contractors work in a timely manner; unavailability of resources; average delay in regular payment (RII = 0.90, 0.86 and 0.86) respectively. And other factors were important (RII = 0.74 and 0.75). On the average, cost related factor affecting contractors' performance was very important (average RII = 0.83)

Quality related factors affecting contractor' performance are very important in design team experience; excessive errors or omission; delay in producing design document (RII = 0.97, 0.84 and 0.83) respectively. And other factors were important (RII = 0.71 and 0.63). On the average, quality related factor affecting contractors' performance was very important (average RII = 0.79).

External related factors affecting contractor' performance are very important in government policy (political influence from higher authority); weather conditions; (RII = 0.91 and 0.81) respectively. And other factors were important (RII = 0.79, 0.79 and 0.63). On the average, external related factor affecting contractors' performance was important (average RII = 0.79).

Results of Effect of Cash flow on Contractors' Performance

This section presents and discusses the results of MIS ranking on the effect of cash flow on contractors' performance in order of significant. The results of the MIS here are summarised in Table 4.

Table 4: MIS Ranking on Effect of Cash flow on Contractors' Performance

S/No.	Effect of Cash flow on Contractors' Performance	MIS	Rank	Decision
1	Timely completion of projects	4.83	1st	Very Significant
2	Total abandonment	4.38	2nd	Significant
3	Damage company reputation	4.15	3rd	Significant
4	Quality Project delivery	4.02	4th	Significant
5	Cost overrun	3.98	5th	Significant
6	Poor quality of end product	3.94	6th	Significant
7	Time overrun	3.90	7th	Significant
8	Disputes	3.79	8th	Significant
9	Regular and prompt order of materials	3.65	9th	Significant
10	Arbitration	3.54	10th	Significant
11	Loss of productivity and efficiency	3.44	11th	Fairly Significant
12	Litigation	3.42	12th	Fairly Significant
13	Reduction in the buying on credit by contractor	3.25	13th	Fairly Significant
14	Regular payment for plant higher and acquisition	3.15	14th	Fairly Significant
15	Increase contractor profitability	3.10	15th	Fairly Significant
	Average	3.77		Significant

Source: Researcher's Data Analysis (2019)

Table 4 revealed fifteen (15) effect of cash flow on contractors' performance. Timely completion of projects was ranked very significant (MIS = 4.83). Nine (9) of these effects are ranked significant. These rang between Total abandonment (MIS = 4.38) and Arbitration (MIS = 3.54). The last five effects were ranked fairly significant. These are Loss of productivity and efficiency, Litigation, Reduction in the buying on credit by contractor, Regular payment for plant higher and acquisition and Increase contractor profitability with MIS of 3.44, 3.42, 3.25, 3.15 and 3.10 respectively. On the average, the effects of cash flow on contractors' performance are significant with average MIS of 3.77. This implies that the level of significance is 75.4% on a five-point scale. This agrees with the finding of Nnadi *at el.* (2017)

which also identified Timely completion of projects as the major effect of cash flow on contractors' performance.

Strategies for Improving Contractors' Performance

The results of the MIS ranking of the strategies for improving contractors' performance is presented and discussed in this section. Table 5 presents a summary of the results of the identified strategies for improving contractors' performance.

From Table 5, twenty-two (22) effective strategies have been identified as strategies for strategies for improving contractors' performance. These strategies range from having appropriate planning (MIS = 4.75) which is very effective and Full cooperation of consultants to contractors or clients (MIS = 3.37) which is fairly effective. On the average, the identified strategies for improving contractors' performance have MIS of 3.87 implying that the strategies are effective and are capable of improving contractors' performance by 77.4%. Agrees with the finding of Olanipekun *et al.* (2017) which also identified having appropriate planning as the most effective strategies for improving contractors' performance in building construction project.

Table 5: MIS Ranking on Strategies for Improving Contractors' Performance

S/No.	Strategies for Improving Contractors' Performance	MIS	Rank	Decision
1	Having appropriate planning	4.75	1st	Very Effective
2	Understanding peoples requirements and needs	4.38	2nd	Effective
3	Good leadership	4.25	3rd	Effective
4	Good communication	4.19	4th	Effective
5	Effective contractors and workers relationship	4.10	5th	Effective
6	Timely documentation	4.06	6th	Effective
7	Stakeholder relationship	4.04	7th	Effective
8	Control and administrative system	3.98	8th	Effective
9	Contractors' progress payment on time	3.88	9th	Effective
10	Comprehensive analysis	3.87	10th	Effective
11	Conformance	3.83	11th	Effective
12	Employee empowerment	3.75	12th	Effective
13	Reliability	3.75	12th	Effective
14	Taking accountability	3.73	14th	Effective
15	Minimize change orders during construction to avoid delays	3.73	14th	Effective
16	Hassle free building solution	3.69	16th	Effective
17	Serviceability	3.67	17th	Effective
18	Less paper work	3.65	18th	Effective
19	Plan cash flow by utilizing progress payment	3.54	19th	Effective
20	Existence of key personnel	3.44	20th	Fairly Effective
21	Use of technology when giving information	3.40	21st	Fairly Effective
22	Full cooperation of consultants to contractors or clients	3.37	22nd	Fairly Effective
	Average	3.87		Effective

Source: Researcher's Data Analysis (2019)

CONCLUSIONS

Cash flow is important to any business. It means in the end the survival or the loss of a company depends on the cash flow. This study has brought into focus the effect of cash flow on contractors' performance. After a series of extensive literature review and findings, it was concluded that there are three (3) most important factors affecting contractors' cash flow and

the major one is improper planning and management, as such, effective planning and management should always be put in place. It is however finally concluded that the effect of cash flow on contractors' performance in building construction projects in Niger State is significant.

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Assessment of Cost Control Techniques on Road Construction Project Delivery in FCT Abuja, Nigeria

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Abstract:

The advancement of technology in the last century has contributed to the increase in the number of complex construction projects that require proactive management. Cost control should be seen as an important management tool that is crucial to the survival of a construction company. This study examining the various cost control techniques used in road construction projects and the effect they have on project delivery. The emphasis here is limited to study the Contractor's point of view. The main concern of the study is to assess the impact of cost control techniques used in road construction projects with a view of project delivery using Inferential Data Analysis. The other focusing areas are to identify cost control techniques used, the challenges of cost control techniques and examine the most effective cost control technique. The preliminary data for this research has been collected through a literature review and well-structured questionnaire survey targeted contractors of Road Construction. This study reveals six commonly used cost control techniques which include Cash Flow Analysis, Valuation of work in Progress, Cost Control, Materials Management, Budgetary Control and Cost Value Reconciliation. The findings further illustrate that the most frequently used cost control techniques in road construction projects was Cash Flow Analysis (CFA). The study concludes that cost control techniques have strong impact on road construction project delivery and lack of knowledge on the use of available tools and technology affect the practice of cost control techniques. It is recommended that Quantity Surveyors should involve in road construction and construction firm should try applying other techniques on projects for better performance.

Keywords: *Construction, Road, Control, Cost, Techniques*.

INTRODUCTION

The Construction industry is a key sector in every country as it is heavily interrelated with the economy as a whole. It affects, and is affected by; the gross domestic product of a nation. Moreover, the construction industry is dependent on different types of input such as human capital, financing and outcomes from other industries (Murendeni and Clinton, 2018). According to Aliu (2014) the built environment consists of Building, Civil and Heavy Engineering works. The construction industry has impact on the environment, economy, and society, explained by (Kucukvar & Tatari, 2013; Onat *et al.*, 2014). The construction industry is one of the most active sectors propelling the Nigerian economy. The construction project can vary from extremely profitable to barely worth it and sometimes end up costing the contractor more than what he or she is getting paid to complete it (Urmila, 2015). In construction industry the aim of project control is to ensure the projects finish on time, within budget and achieving other project activities. The advancement of technology in the last century has contributed to the increase in the number of complex construction projects that require proactive management. Adjei *et al.* (2015); Sanni and Hashim (2013) concluded that ″cost control is an element of financial control since it supplements managerial control process in the organisation″. Cost control should be seen as an important management tool that is crucial to the survival of a construction company. According to Adjei *et al.* (2018), cost control practice is a process whereby the cost of the construction project is monitored, evaluated and compares the planned budgeted cost with the actual site cost for decisions to be made to bring the cost on track. The need to control cost is important in order to eliminate the unnecessary

wastages of resources. The practice of cost control is a required task for the survival and growth of every construction organization in every nation. The rehearsal of cost control assists organizations to eliminate and/or reduce unnecessary wastage of resources in the execution of construction projects (Bahaudin *et al*., 2012; Adjei *et al*., 2017). The cost control principles are also expected to act as telltale or offer early warning system, notifications of possible budget difficulties at predetermined periods for corrective measures to be decided to solve the cost variances. Opatunji (2018) establish the cost control techniques used among construction Practitioners such as Budgetary control, Cash flow analysis, Earned value management, Cost reduction on site, Material management, Risk analysis, Cost planning, Work programmes, Valuation of work in Progress few among others. In the opinion of Adjei *et al*., (2017); Khamidi *et al*., (2011) the project quantity surveyor or the cost engineer needs to apply the cost control techniques to develop a series of options for the other project members to consider and select one of the best options that fit within the approved budget limit. In the construction industry, very little study has been conducted on the challenges of cost control. Researchers such as Adjei *et al*., (2017); identified challenges of Cost Control Practice in the construction industry with very limited literature review and Kirun and Varghese (2015); a literature review was conducted to identify major problems, the techniques used for identify the problem is Delphi techniques. In order to address those problems, this research is aimed to examine various cost control techniques used in road construction projects and the effect they have on project delivery.

LITERATURE REVIEW

The Evolving Roles of Professional Quantity Surveyor in Road Construction

The construction industry comprises of many stakeholders such as clients, design professional, construction professionals, and operational teams. The major professionals in the industry in terms of their initial contact with the client and involvement with the design and construction stages of the construction projects includes engineers (notably civil, electrical and mechanical), building engineers, quantity surveyors or cost estimators and architects. The civil engineers are concerned with public constructions (i.e. roads, dams, quays, shipyards, and bridges) (Olanrewaju and Anahwe, 2015). The RICS (1971) emphasized that the distinctive competencies or skills of the quantity surveyor (QS) are associated with measurement and valuation which provide the basis for the proper cost management of the construction project in the context of forecasting, analysing, planning, controlling and accounting. A quantity surveyor is a professional in the road construction who has the ability to analyse both cost components and practical physical construction works of a project in a successful way so as to be able to apply the results of his analysis in solving problems peculiar to each project (Timothy and Amos, 2016). Quantity surveyors are involved in various types of construction including mining, petrochemical plants and refineries construction and installations (Olanrewaju and Anahwe, 2015). The traditional role of QS on road construction mainly concerns cost management such as cost estimation, the advice at design stage, Cost control, valuations, variations and final accounts.

Cost Planning

As a process, cost planning is difficult to define concisely. This difficulty exists because the cost planning process involves a diversity of procedures and techniques that are used simultaneously by the quantity surveyor (QS) or construction economist (Boussabaine, 2013).

Kirkham (2014) are of the view that traditionally, cost planning will typically follow the conventional outline design-scheme, design-detailed design process. Similarly, Kissi and Adjei-Kumi (2017) stated that, cost planning covers every aspect of cost control in a construction project thus from the inception to completion with the aim of delivering project to satisfy the client's expectation, which is within budget, at the desired quality and delivered within the agreed time.

Cost Control and Monitoring

Cost control is a process where the construction cost of the project is managed through the best methods and techniques so that the contractor does not suffer losses when carrying out the activities of the project (Opatunji, 2018). One of the aims of cost control according to George, *et al*. (2012) is to construct at the cheapest possible costs consistent with the project objectives. Cost control involves the measurement of the performance of a design against a standard i.e. cost target/cost plan and taking any remedial actions where necessary. Cost control can be classified into pre-contract and post contract cost control. Pre-contract cost control starts at the inception stage to the tender action stage while post contract cost control starts from the project planning stage to the completion stage. From this it is obvious that cost control should be continued through the construction period to ensure that the cost of the building is kept within the limits. The control of project cost is not an easy task and it requires knowledge of applying cost controlling techniques (Opatunji, 2018).

Cost Control Techniques

The primary responsibility of project management is to control the cost of the project, time, performance and quality goals. Cost management is a one of the important tasks which drives project to a successful completion. This includes resource planning, cost budgeting, cost estimating and cost control. This cost management process can be enhanced through different software's, tools and techniques in order to control the costs. According to 'Project management book of knowledge (PMBOK)' there are few techniques which would be useful for monitor and control construction project. According to Malkanthi, *et al*. (2017), most of the contractors in Sri Lanka believed that they can reduce about 50% of their overhead cost by using proper cost controlling techniques. Some contractors have already achieved more than 50% overhead reduction through cost controlling techniques. Thus, a proper cost controlling can be considered as an essential component in the construction industry. Various cost control tools and techniques are adopted by the project managers with the aim of mitigating the cost uncertainties during project implementation. According to Rodriguez (2011); Scott (2012); Burke (2013); Cooray *et al*. (2018); over the years, cost control techniques have evolved and some of those techniques are; Earn value management (EVM), Programme Evaluation and Review Techniques (PERT), Critical Path Method (CPM), To-complete performance index (TCPI), Risk Analysis, Cost value reconciliation (CVR), Monte Carlo simulation, Whole life costing etc. Other Techniques identified by (Opatunji, 2018; Anyanwu, 2013) include: Performance reviews and Variance Analysis, Budgetary control, Cash Flow Analysis, Site Meetings, Record keeping, Valuation of work in Progress, Elemental Analysis, Cost optimization techniques, Cost Reduction on site, Cost Planning, Work Programs, Material Management in addition to that, software applications such as Asta Power Project, Primavera, Microsoft Project are available to control the costs incur in the road construction projects (Cooray *et al*., 2018).

Challenges of Cost Control Techniques

Adjei, *et al*. (2017) identified the following challenges of cost control techniques in his research:

1. Lack of consistency in cost management by managers/Project Quantity Surveyor
2. Lack of knowledge on the use of available tools and technology
3. Abandonment of complicated strategies
4. Using obsolete Methods and Concepts
5. Lack of financial commitment in projects
6. Lacking PCC processes and systems suitable to the enterprise

Other Challenged Identified by Malkanthi, *et al.*, (2017) include:

1. Fluctuation in prices of Raw Materials
2. Poor Project Site Management
3. Lowest Bidding Procurement Method
4. Inappropriate Government Policies
5. Wrong method of Cost estimating
6. Duration of the project

RESEARCH METHODOLOGY

This research depended on both qualitative and quantitative information obtained through a questionnaire survey conducted among professionals working at the level of project managers, site managers, etc., in the construction industry. The questionnaire was developed based on the information gathered during the preliminary survey which was in the form of onsite interviews. The preliminary questionnaire was prepared using the knowledge gained from the literature review.

A research population is generally a large collection of individuals or objects that is the main focus of a scientific query (Mohamed, 2017). Kolo (2003) supported that; population is a group of people that have a similar character which the researcher may have on them. The target population for this study comprise of Thirty (30) construction firms in Abuja metropolis registered with Federation of Construction Industry in Nigeria (FOCI), Nigeria. However, only one professional was administered in each firm. The sample frame for this research consisted of Quantity surveyors, Project Managers and Civil Engineers working in construction firms (dealing with road construction only) in Abuja registered with and contained in the list of contractors complied by FOCI Nigeria. For this research, primary sources of data collection were employed. The primary data was gotten from the administration of well-structured questionnaires.

After collecting the information from the respondents via the structured questionnaire, the data gathered were carefully analysed in relation to the stated objectives. The data were analysed using descriptive statistical method (Percentile, Frequency, Mean Item Score and Relative Importance Index) with the aid of SPSS statistical package.

Mean Item Score is being ranked from 1.00 to 5.00. The formula for Mean item score (MIS) is as equation 1.0.

$$\text{MIS} = \frac{\Sigma W}{N} \qquad (1.0)$$

Where: Σ = Summation, W = Weight, and N = Total number respondent

The decision rule here states that:

- If R ≥ 50% then Correlation is strong.
- If R < 50% then Correlation is weak.

RESULTS AND DISCUSSION

The survey started by identifying the respondents' backgrounds such as their genders, experiences in terms of years, level of education, discipline and professional membership. It helped to ensure that the data collected were reliable. The research was focussed on finding out the cost control technique(s) used in road construction project. Table 1 shows that contractors believe that Cash flow analysis as cost control techniques is the highest used in road construction project with 24% and response count of 6 follow by valuation of working in progress which account for 20% with a count of responses from respondents as 5. Cost value reconciliation and material management had 16% with a count of responses from respondents as 4 each. Finally, budgetary control and cost planning had the smallest amount of responses a count of 3, counting for 12% for each cost control techniques. This implies that cash flow analysis is the most effective cost control technique, use in road construction project.

Table 1: Cost Control Technique(s)

Cost Control Technique(s)	Frequency	Percent
Cash Flow Analysis (CFA)	6	24
Valuation of Work in Progress (VWP)	5	20
Cost value reconciliation (CVR)	4	16
Material Management (MM)	4	16
Budgetary control	3	12
Cost Planning	3	12
Total	25	100

Source: Researcher's Data Analysis (2020)

Table 2 shows the challenges of the cost control techniques used in road construction project. Challenges such as lack of knowledge on the use of available tools and technology, lack of financial commitment in projects and fluctuation in prices of raw materials were ranked first (1st), second (2nd) and third (3rd) with a mean score of 4.36, 4.24 and 4.20 respectively. Lack of consistency in cost management by managers/project Quantity Surveyor ranked fourth (4th) with a mean score of 4.16, lowest bidding procurement method with a mean score of 4.12 ranked fifth (5th) while poor project site management was on the sixth (6th) rank with a mean score of 3.88.

Table 2: Challenges of the Cost Control Techniques Used in Road Construction Project

S/No	Challenges of Cost Control Techniques	MIS	Rank	Remark
1	Lack of knowledge on the use of available tools and technology	4.36	1st	Agreed
2	Lack of financial commitment in projects	4.24	2nd	Agreed
3	Fluctuation in prices of Raw Materials	4.20	3rd	Agreed
4	Lack of consistency in cost management by managers/Project Quantity Surveyor	4.16	4th	Agreed
5	Lowest bidding Procurement method	4.12	5th	Agreed
6	Poor Project Site Management.	3.88	6th	Agreed
7	Using obsolete Methods and Concepts	3.84	7th	Agreed
8	Inappropriate Government Policy	3.80	8th	Agreed
9	Lacking PCC processes and systems suitable to the enterprise	3.72	9th	Agreed
10	Wrong method of Cost estimating	3.68	10th	Agreed
11	Abandonment of complicated strategies	3.64	11th	Agreed

Source: Researcher's Data Analysis (2020)

Using obsolete methods and concepts had a mean score of 3.84 and ranked seventh (7^{th}) while on the eight (8^{th}) rank was inappropriate government policy with a mean score of 3.80. Challenges such as lacking PCC processes and systems suitable to the enterprise and wrong method of cost estimating ranked ninth (9^{th}) and tenth (10^{th}) with a mean score of 3.72 and 3.68 respectively. The least ranked challenge was abandonment of complicated strategies which came eleventh (11^{th}) with a mean score of 3.64.

Table 3 shows the research data for this research. Archival data were collected on Initial Contract Sum (ICS) and Final Contract Sum (FCS) from ten (10) recent projects.

Thus, it was revealed that cost control techniques have effect on the cost of various road construction projects executed by construction firms in Abuja.

Inferential Data Analysis

Pearson Correlation was employed as a tool for inferential analysis in the study to establish the effect of cost control techniques on road construction project delivery.

Results and Discussion for Pearson Correlation Analysis

One analysis was carried out using the Pearson Correlation Analysis in order to establish the impacts of cost control techniques on road construction project delivery

Table 3: Analyse Effect of Cost Control Techniques on Road Construction Project Delivery

Project year	Project particulars (Title)	Type of technique used	Initial Contract sum (~~₦~~)	Final contract sum **(N)**	Cost difference **(N)**	% difference
2015	A	Cash Flow Analysis (CFA)	969,000,000.00	860,000,000.00	-109,000,000.00	-11.25
2015	B	Valuation of Work in Progress (VWP)	833,000,000.00	784,000,000.00	-49,000,000.00	-5.88
2015	C	Cash Flow Analysis (CFA)	4,200,000,000.00	4,254,250,000.00	54,250,000.00	1.29
2016	D	Material Management (MM)	808,000,000.00	840,300,000.00	32,300,000.00	4.00
2017	E	Budgetary control (BC)	684,700,456.30	650,588,089.92	-34,112,366.38	-4.98
2017	F	Cost value reconciliation (CVR)	329,756,362.24	319,147,828.80	-10,608,533.44	-3.22
2018	G	Cash Flow Analysis (CFA)	107,555,555.20	119,334,577.28	11,779,022.08	10.95
2019	H	Valuation of Work in Progress (VWP)	2,248,000,000.00	1,212,000,000.00	-1,036,000,000.00	-46.09
2019	I	Valuation of Work in Progress (VWP)	1,056,000,000.00	855,000,000.00	-201,000,000.00	-19.03
2019	J	Cost value reconciliation CVR)	1,366,449,752.08	2,265,201,407.06	898,751,654.98	65.77
					Average	-0.84
					Min.	-46.09
					Max.	65.77

Source: Researcher's Data Analysis (2020)

It was observed from the analysis that there exists a strong, positive and significant relationship between the initial contract sum and final contract sum. The correlation coefficient (R value) observed was 75% indicating strong degree of association between the variables. The positive correlation observed between the variables indicates a tendency that an increase in the initial contract sum will lead to an increase in the final contract sum and decrease in the initial contract

sum will lead to decrease in the final contract sum. Thus, Table 4 summarised the results of these analysis

Table 4: Results of Pearson Correlation Analysis

	Variables		Observations		Inferences	
Analysis No.	X_1	X_2	R (%)	P_{value}	Strength of Relationship	Remark
1	Initial Contract Sum	Final Contract Sum	75.00	0.012	Strong	S

Source: Researcher's Analysis of Data (2020)

KEY: S = Significant

Summary of Findings

The study was set out to address the cost control techniques used in road construction projects. To solve this, the study assessed cost control techniques used in road construction projects and the impact they have on project delivery. To achieve this aim, data was collected from construction firms (dealing with road construction only) in Abuja. The retrieved data was analysed with the aid of descriptive statistics. The following are the discoveries made from the analysis carried out from the study:

i. The most frequently used cost control techniques in road construction projects was Cash Flow Analysis (CFA) with 6 frequency and 24%.
ii. Lack of knowledge on the use of available tools and technology (MIS=4.36) was the most agreed challenges of the cost control techniques used in road construction project.
iii. There was a strong, positive and significant relationship between the initial contract sum and final contract sum. However, increase in the initial contract sum will lead to an increase in the final contract sum and vice versa.
iv. There exists a statistically significant impact of cost control techniques on road construction project delivery.

CONCLUSION AND RECOMMENDATIONS

Conclusion

From the study, the cost control techniques investigated, only 6(six) out of 19(nineteen) are used on average in the road construction in Abuja, Nigeria and also few Quantity Surveyors (Cost Manager) are involved in the critical cost management of road construction projects on like building projects. The study reveals that cost control techniques have strong impact on road construction project delivery. The research shows that lack of knowledge on the use of available tools and technology affect the practice of cost control techniques.

Recommendations

The focal point of this study was to examine various cost control techniques used in road construction projects and the effect they have on project delivery.
Based on the study, the following recommendations are being made;

i. Quantity surveyors should involve in road construction due to the area of their discipline as cost expertise which they have better attitude towards using these techniques.

ii. The cost manager should also exhibit the foresight in predicting and arresting those constraints that are associated with road projects which may either retard the progress of work or extend the predetermined project duration, thus increasing project cost.
iii. Construction firm should try applying other techniques on projects for better performance.
iv. Construction firms should endeavor to send their employees to attend workshops, seminars and other training programs that will enlighten them on how to use the other techniques.

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Cost of Implementing Health and Safety Measures in Construction Projects in Abuja, Nigeria

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Abstract:

The high rates of construction accidents as well as increase in construction cost due to accidents have been an issue of concern. The cost of health and safety during forecasting the construction cost is given little or no emphasis. This has become a threat to both contractors and their clients and has also posed great challenges in project executions with its multiplying effect on incurring additional cost in completing the project, and as such certain contractors and sub-contractors pay little or no attention in implementing health and safety measures. Hence, the aim of this study is to determine the cost of implementing health and safety measures in construction projects. The study is a criteria – based study, in which certain criteria were outline for the selection of the construction firms. The study largely derives quantitative measure in order to determine the cost of implementing health and safety measures on construction projects. Quantity surveyors with vast knowledge of health and safety in the construction firms were considered for this research. Correlation analysis was conducted in order to determine the relationship between cost of implementing health and safety measures and cost of construction projects and the result was found to be significant ($P < 0.005$). This relationship was modeled using simple linear regression and from the model the result shows that the cost of implementing of health and safety measures have little or no effect on the total cost of construction project. The findings recommend the need for contractors to implement an effective and efficient health and safety cost management system in the Nigeria construction industry, as this will help them in achieving an improvement on construction site safety performance.

Keywords: Accidents, Cost, Health, Safety, Measures.

INTRODUCTION

The laws governing construction health and safety requires full action and implementation to protect workers at their work place as well as the general public who might be affected. Occupational health and safety Act (OSHAct) of 1994 obligates employers to make good and adequate provision of health and safety measures in work places, and also maintain a safe and healthy workplace for all its employees. According to Aneikwu, (2007), more than hundred million people in various part of the world part take in construction works as a profession.

The implementation of health and safety measures in construction projects remains one of the integral parameters to which successful projects delivery can be obtained. This fact is buttressed as health and safety plan/policy is one of the parameters in prequalifying suitable contractors for the award of construction projects in Nigeria (Windapo, 2013).

The growing rate of construction accidents has increased the awareness of construction health and safety, thereby involving its inclusion as part of project performance criteria. Adekunbi *et al*., (2017) opined that the absence to make adequate provision of health and safety regulations and bye laws on construction projects may be one of the contributing recipe to high cost of construction. This indicates the necessity for adopting a reasonable health and safety plan during budgeting for construction projects.

LITERATURE REVIEW

Construction Health and Safety Measures

Ahmad, Iqbal, Rashid, Iqbal and Roomi (2016) defined safety as unique event that is paramount to continuous attainment of productivity. In the same vein, Ahmad, *et al*., (2016) opined that

safety focus on curbing accidents at work setting and its negative effect on the workers in all manner. Assessment of various researchers such as: Aniekwu (2007); Idoro (2011); Okolie and Okoye (2012); Idubor and Oisamoje (2013); Dodo (2014); and Umeokafor *et al.*, (2014); on provisions and management of safety in construction project reveals that adoption and compliance with health and safety provision served as catalyst in optimizing construction production process. On the other hand, without compliance to health and safety practices, more accident will result in pains, accidents and legal actions thereby escalating production cost. Based on this, Famakin & Fawehinmi (2012) stated that safety practices are parameter to measure successful project delivery which is most paramount to the client because they greatly influenced in achieving efficiency and effectiveness amongst professionals and even workers in the construction industry.

The anomalies as seen in the construction firm's failure to comply with minimum requirement of health and safety measures might cause the victim waste of time and loss of money to the firms. Although construction firms may be covered with life assurance for their staffers from certain direct costs resulting from injury suffered, however some tectonic cost may be involved which cannot be insured against, such as loss of trained personnel, loss of production hours due to other operatives stopping the progress of the work out of concern or assisting the injured persons (Aniekwu, 2007). Thus, the lack of adherence to safety measures will delay the production process of construction activities.

Kolawole (2014) assessed safety measures on building sites: a case study of Minna, North Central Nigeria. The study examined safety approach adopted in Minna construction firms, it also evaluates if implementation of safety regulation will reduce workers claim for accident on sites or motivate them for better performance. Population needed for the study were randomly selected among building construction firms through copies of structured questionnaire. Result from the analysis noted that site workers embraced "safety training" as this enhances their performances and reduced accidents on site and also government did not have well defined safety act for construction activities. The study recommended training and re-training of their workers on the relevance of safety practices, while government should develop and enact "safety act" for controlling site based injury.

Cost of Health and Safety Measures

In order to maintain a healthy working environment, the cost of health and safety are those incurred in order to comply with legal requirements with respect to accident prevention, to implement measures to prevent accidents during work and to improve health and safety conditions in all areas of the work performed. The cost of health and safety was generally perceived as a necessary and beneficial business expense (Okoye and Okolie, 2014). According to Haefeli *et al.* (2005) avoidance or reduction of accident and work-related ill health costs per se does not appear to be the primary motivating factor for effective health and safety management. However, Haefeli *et al.* (2005) acknowledged that health and safety failures might ultimately impact on the financial performance of an organization through any of the higher level factors like customers and client expectation, workers morale, productivity, efficiency and service delivery etc. in view of the above position Guha and Biswas, (2013), argue that safety investment cannot be absolute and a rational judgment for safety cost is required and maintain that costs associated with safety parameters in developing countries might simply be unjustifiable and that the stakeholders cannot bear the safety cost for economic survival if the real cost of accident is too low in the economy.

RESEARCH METHODOLOGY

According to Creswell, (2003) that the factor to be consider in selecting the best research methodology should be the influence that such method has on the research problem and objectives. The study largely derives quantitative measure in order to determine the cost of implementing health and safety measures on construction projects. Quantity surveyors with vast knowledge of health and safety in the construction firms were considered for this research.

The study is a criteria – based study, in which certain criteria were outline for the selection of the construction firms. Those criteria are:

1. The construction company must be built/civil engineering, construction.
2. The location of the study is Abuja, the Nigeria federal capital.
3. The contract sum must be at least or above 100 million.
4. The construction firm or company must be more than twenty (20) years in civil/building construction work.
5. The quantity surveyors selected for this study must at least be with the construction firm for not less than fifteen (15) years.
6. The construction firm must be a large firm. The reason is that large construction firms tends to have records to safety standard requirements.
7. The construction projects are within a period of seventeen (17) years 2001-2018.

Table 1: Sample Population

S/N	CONSTRUCTION FIRMS	TOTAL NO OF PROJECTS
1	A	8
2	B	5
3	C	7
4	D	9
5	E	4
	TOTAL	33

Source: - Researchers survey 2019

Five (5) construction firm were identified that meet the study criteria and as such five (5) of the construction firms were selected for the study. A total of thirty-three (33) construction projects with the implementation of health and safety measures also meet the research criterial which was drawn from the five (5) construction firms.

There was no any sample selection rule adopted this was to make the result reliable and valid because according to Tim Edwin Colbourn of the University College London (2013) that many researchers opined that "the confidence interval surrounding a statistical test results tells you how much you can generalize your results to the whole population as it will tell you the likely range the result will take in the total population, so the larger your sample, the narrower your result which makes your statistical tests more powerful". The analysis of the data was undertaken using the statistical package for social science (SPSS) version 20. Which is a software package used for statistical analysis. It is now named "IBM SPSS Statistics". It is manufacture in Chicago USA, by SPSS Inc. The SPSS Inc. is a leading global manufacturer of software used in data analysis, reporting and modeling. In social science study.

RESULT AND DISCUSSION

Correlation analysis was conducted in order to determine the relationship between the cost of implementing health and safety measures and cost of construction projects. Table 2 shows the result of the correlation analysis.

Table 2: Total cost of building construction projects (TCBCP)

Component	R	P
CIMHSM	0.030	0.001

listwise N=140

Source: Researcher analysis (2019)

Where;

CIMHSM =Cost of implementing health and safety measures.

CCP =cost of construction projects.

Table 2 reveal the correlation of cost of implementing health and safety measures and cost of construction projects, and their correlation is significant at the 0.01 level (2- tailed). N = 140. The Pearson's correlation of the table reveals a positive, strong and highly significant relationship between; Cost of implementing health and safety measures and cost of construction projects.

The Pearson's correlation (r*)* from table 2 is 0.030 while its P< 0.001. This means that the implementation of health and safety measures has a weak relationship on the cost of construction projects or implementation of health and safety measures will only have little or no significant effect on the cost of construction projects. Following the existence of a positive relationship between the variables, there is a need to predict the outcome of the variables. Therefore, simple linear regression was adopted, the simple linear regression seeks to examine the effect of implementing health and safety measures on the cost of construction projects. In the simple linear regression model develop cost of construction projects is the dependent variable while cost of implementing health and safety measures is the independent variable. The results of simple linear regression analysis are presented in Table 3

Table 3: Model Summary (Total cost of building construction projects)

Model	R	R square	Adjusted R square	Std. error of the estimate
1	.698[a]	.486	.486	1.54887

a. Predictors: (Constant): CIMHSM

b. Dependent Variable: CCP

Source: Researcher analysis (2019)

Table 3 shows that 48% (R2 = 48) of the proportion of variation in total cost of construction projects by the level of cost of implementation of health and safety measures. The R2 adjusted is 0.486 implying that the model explains 49% of the variation in the cost of construction projects within the population leaving 51% unexplained. The cost of implementation of health and safety measures fail to explain all possible variation in the cost of construction projects. Failure to comply with minimum requirement of health and safety measures which might cause

the victim waste of time and loss of money to the firms, are responsible for such knowledge failure.

CONCLUSION AND RECOMMENDATION

The cost of implementing health and safety measures and cost of construction projects was determined. The study concluded that cost of implementation of health and safety measures have little or no consequences on the cost of construction projects. It was revealed that a reasonable correlation exists between cost of implementing health and safety measures and the cost of construction projects as ($r = 0.030$, $P < 0.001$). This means that cost of implementing of health and safety measures has little or no effect on the cost of construction projects. The regression models finding indicates that the analysis of the data also revealed that implementing health and safety measures tends to have little or no increase on the cost of construction projects but instead non-conformance to the implementation of health and safety measures which often result to accident will in turn increase the overall total cost of construction projects. In line with the findings of this research, the study recommends that Severe measures and punishments should be meted out to contractors who violate safety policy, and where there is a recurring violation of policies, the contractor certificate may be rescinded, appointment of a safety officer by a construction company to primarily ensure or enforce health and safety measures e.g., ensuring that workers wear safety boots and helmets etc. and lastly on the job as well as off the job training should be provided to the employees on their health and safety impact on the output of the project.

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Conceptual Framework for an Effective Management of Public-Private Partnership Infrastructure Project Stakeholders to Minimise Project Failure in North Central, Nigeria

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Abstract:

Public- Private Partnership (PPP) brings together the Private sector managerial expertise and Public sector regulatory and supervisory capacity in the provision of public infrastructure projects. Several problems have been encountered on PPP initiatives in Nigeria, especially in the North Central region where many PPP infrastructure projects have experienced challenges and failures as a result of stakeholder's opposition and disagreements arising from the neglect of stakeholders' interest. Previous research have developed frameworks and models for managing project stakeholders in conventional procurement system which is unsuitable for managing the challenges of stakeholders in PPP infrastructure projects. As such, identification and management of stakeholders in PPPs is crucial to the success of PPP projects. Hence, there is need to develop a conceptual framework upon which an effective strategy to minimise PPP infrastructure projects failure through effective stakeholders management amidst well designed institutional and regulatory framework and a conducive investment climate. This research intends to bridge the gap in the literature by providing an operational strategy to minimise failure of PPP infrastructure projects through effective management of PPP project stakeholders in North Central region of Nigeria. This strategy could be applied to minimise PPP infrastructure failure in developing countries.

Keywords: Conceptual Framework, Failure, Nigeria, Public-Private Partnership Infrastructure projects, Stakeholders.

INTRODUCTION

Public-Private Partnerships have become a popular institutional arrangement and many public infrastructure projects such as Roads, rail, airports, hospitals, housing, schools among others have been procured through PPP, yet many PPP infrastructure projects have experienced some challenges that lead to undesirable outcomes such as delays, litigations, terminations, revocation of concessions and failures as a result of stakeholder's opposition and resistance (Amadi *et al.*, 2014; Babatunde, 2015). This is corroborated by El-Gohary *et al.* (2006) that stakeholder's conflicts are the main causes of PPP project failures. However, end users and other stakeholder's resistance in PPP occur where charges are expected to be collected directly from the users on the use of public infrastructures such as; Roads, water facilities, electricity among others (World Economic Forum 2010; El-Gohary *et al.*, 2006).

Stakeholders are groups, individuals or organisation that are either affected by or affect the implementation of PPP infrastructure projects. (Freeman, *et al.*, 2010). PPP stakeholders includes; political bodies, government authorities (MDAs), consultants, private investors/concessionaires, contractors, sub-contractors/suppliers, financial institutions, operation and maintenance organisations, users and community at large. For PPP project to be successful, it is important to involve and manage all PPP stakeholders from the initiation stage to the completion stage of the project (El-Gohary *et al.*, 2006). Stakeholder management has

the capacity to provide strategic information, resources and problem-solving techniques and also offer all stakeholders the opportunity to contribute meaningfully towards the success of the PPP projects (Foo *et al.*, 2011; Amadi *et al.*, 2014).

PPPs which is globally perceived as a medium for infrastructure deficit reduction, has become controversial in Nigeria as a result of stakeholders opposition and resistance. Thus, causing diminishing interest for both the local and foreign private investors (Amadi *et al.,* 2014; Babatunde *et al*., 2015). Despite the adoption of PPP in Nigeria, there are still challenges that are hampering the development of infrastructure under PPPs, especially in the North Central region of Nigeria. Though, several frameworks and models have been developed for managing project stakeholders in conventional procurement system, nevertheless, there is no known framework developed for managing the challenges of stakeholders in PPP infrastructure projects in Nigeria. As such, this paper proposes the development of a conceptual framework for stakeholder's management in PPP infrastructure projects with a view to minimising failure of PPP projects, with specific focus on the North Central region of Nigeria.

2.0 PUBLIC- PRIVATE PARTNERSHIP INFRASTRUCTURE PROJECTS DEVELOPMENT IN NIGERIA

The involvement of the private sector in the development and financing of public infrastructure has increased substantially over the past decade (Li *et al.,* 2005). The concept of PPP is now regarded as a veritable tool in the procurement of public facilities and services in Nigeria. PPP is a generic term for the different forms of relationship existing between the public sector and the private sector with the aim of financing, developing, building/constructing and for the effective management of public infrastructure (UNECE 2008; Robinson *et al.,* 2010; Amadi *et al.,* 2014). These relationships are usually long term where the concession arrangement could last up to 35 years to enable the private sector repay loans sourced from the financial institutions (Smyth and Edkins, 2007). There are different types of PPPs that are often implemented. These PPP models differs in terms of both the public and private sector involvement such as: Build-Operate-Transfer (BOT); Build-Own-Operate-Transfer (BOOT); Build-Own-Operate (BOO); Design- Build-Operate-Transfer (DBOT); Design-Build-Finance-Operation (DBFO) among others. PPP has been adopted in the procurement of projects in Nigeria. These projects includes: the concession of Lagos-Ibadan expressway and the new terminal at the Murtala Mohammed Airport both handled by Bi-Courtney Limited, the concession of the first phase of Epe-Lekki toll road in lagos, 105KM Lagos-Ibadan Road, Housing estate development in states including Niger, Adamawa, Ogun, Ondo, Bauchi, Lagos, Federal Capital Territory among others.

2.1 PPP Infrastructure Projects Development in North Central, Nigeria

PPP has been adopted in the provision of public infrastructure projects in Nigeria particularly the North Central region of Nigeria. These Projects includes; the concession of Nnamdi Azikiwe International Airport Abuja, concession for complete infrastructure provision at Katempe, Abuja, the concession for the provision of Minna City housing project in Maikunkele, Construction of Minna Five Star Hotel, The Concession of Benue Cargo airport which was awarded to Aerotropolis Development Company Ltd, construction of Jos Main Market and the provision of Hospital facilities in Jos East, construction of road networks in FCT as the Federal Government pursues the implementation of the Abuja Master plan, Development of 1MW Hydropower Doma Dam in Nasarawa State, among others (Adeogun and Taiwo, 2011; Ibem and Aduwo, 2012; ICRC 2012; Taiwo, 2013; Mudi *et al*., 2015; Ojo,

2017). Despite the increasing adoption of PPPs, in Nigeria including the North Central zone of Nigeria, the experiences of stakeholders, principally the local and foreign investors have not always been positive due to controversies, failures, delays, and revocation of concessions (Babatunde *et al*., 2015; Mudi *et al*., 2015).

2.2 The Stakeholders Theory

The word 'stakeholder' originated from Stanford Research Institute (SRI) in the 1960s (Freeman 1984). Freeman *et al*. (2010) assert that the main idea underlying the stakeholder theory is that the organisations are committed to addressing a set of stakeholders' expectations. Babatunde (2015) further identified the main proponents of stakeholder's theory as follows: the interests of all stakeholders have intrinsic value, and no set of interests are assumed to dominate the others; the theory focuses on management decision-making; and the organisation has relationships with many groups (stakeholders) that affect and are affected by its decisions. Also, Yang *et al.* (2011) identified three-way categorisation of approaches to the stakeholder theory. This includes normative stakeholder theory; descriptive stakeholder theory; and instrumental stakeholder theory. Friedman and Miles (2006) state that normative stakeholder theory encompasses theories of how stakeholders should act and view the purpose of the organisation, based on some ethical principle. Descriptive stakeholder theory is concerned with how stakeholders behave and how they view their actions and roles. Lastly, instrumental stakeholder theory deals with how stakeholders should act if they want to favour and work for their interests (Fontaine *et al*., 2006; Friedman and Miles, 2006; Babatunde, 2015). The advantage that the stakeholder theory offers to PPPs is its normative approach towards stakeholder inclusion focusing on their behavioural patterns and relationship management for project success (Aladpoosh *et al*., 2012; Bakhtawar *et al.*, 2018).

2.2.1 Theoretical framework for managing stakeholders in construction projects

In Figure 1. Yang *et al.* (2010) developed a framework for managing stakeholders in conventional projects where they identified "managing stakeholders with social responsibilities (economic, legal, environmental and ethical)" as the most important critical success factors for success of stakeholder's management. This finding was in line with the studies of (Wood and Gray, 1991; Donalson and Preston, 1995). Economic responsibility according to Yang *et al.* (2010) is the obligation to produce goods and services, sell them at fair prices and make profit, legal responsibility is the obligation to obey the law; and ethical responsibility covers those issues not embodied in law but expected by society. The framework shown in Figure1, is only suitable for managing stakeholders in conventional construction projects and not adequate in addressing the challenges of stakeholders in PPP infrastructure projects as a result of some apparent flows of their processes (Amadi *et al.,* 2014)

2.2.2 Public-Private Partnership Stakeholders

El-Gohary *et al.* (2006) grouped stakeholders into; responsible, impacted or interested. Responsible stakeholder refers to an organisation or individual who has some degree of responsibility or liability with regard to the development PPP projects, such as Public sector (MDAs), Concessionaire, Contractors, Consultants, Financial institutions; among others) as shown in Figure 2. An impacted stakeholder is an organisation or individual who is directly or indirectly affected by the development process; and was classified into three main sub-domains': residents, users and owners. Impacted stakeholders are further grouped as negatively or positively impacted. Finally, an interested stakeholder is an organisation or individual that is not directly impacted by the project, but who would like to participate and provide his

opinion in the infrastructure development process. This includes various players such as social institutions, environmentalists and media representatives.

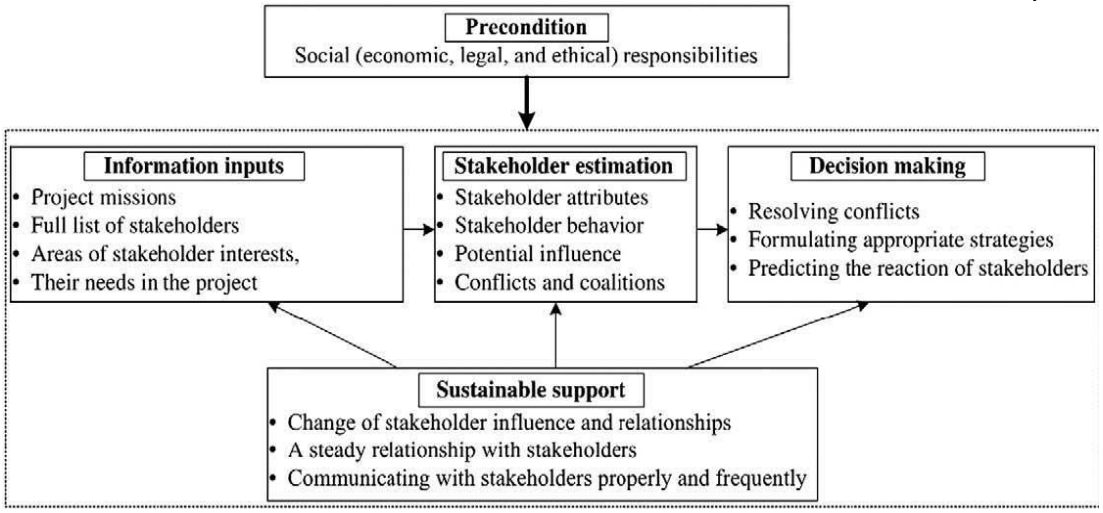

Fig. 1. A framework for successful stakeholder management in construction (Yang et al., 2010)

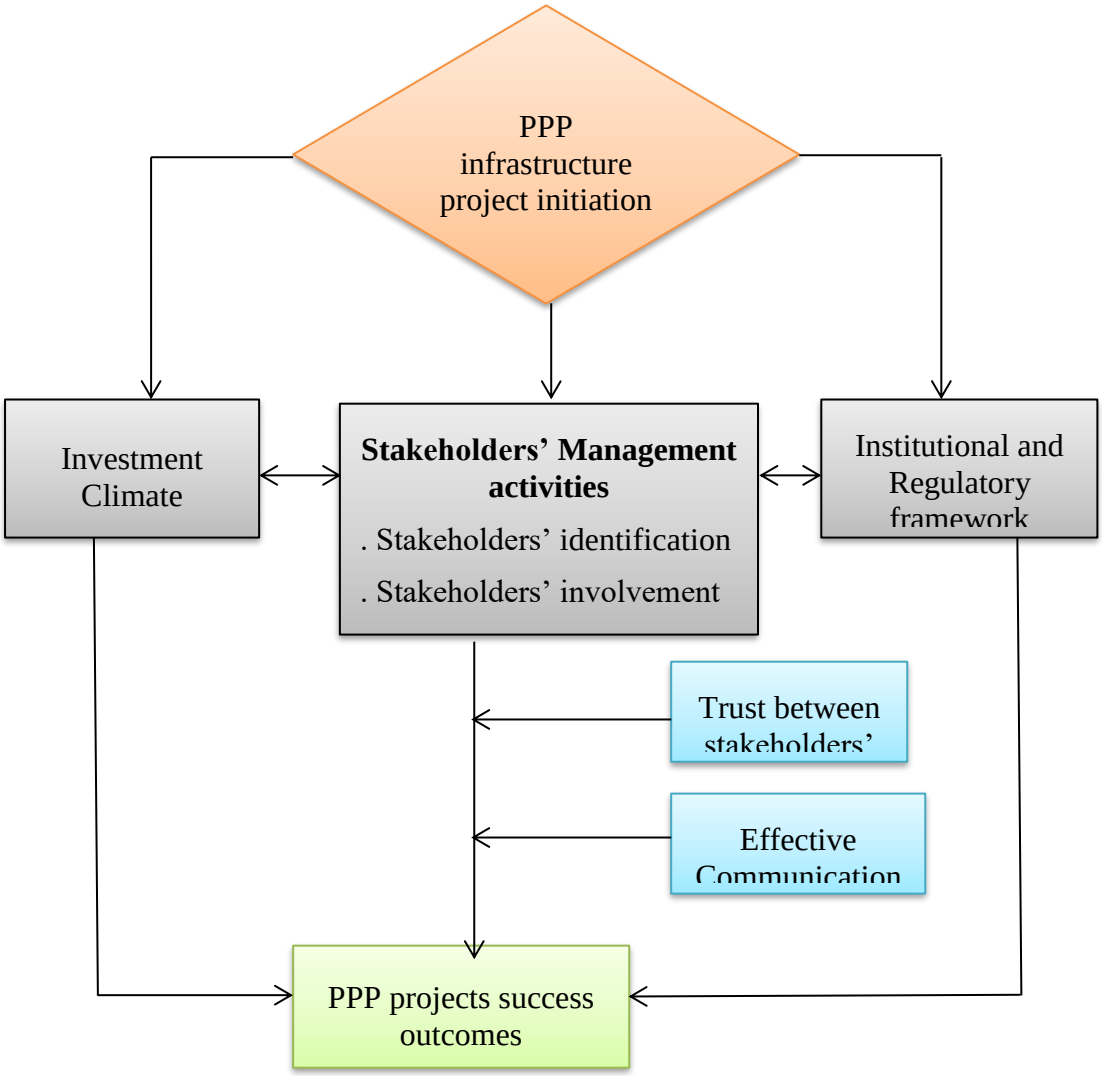

Fig.2: Conceptual Framework for Management of Stakeholders in PPP Projects

3.0 ENHANCING SUCCESS IN PPP PROJECTS: CONCEPTUALISED FRAMEWORK FOR EFFECTIVE MANAGEMNT OF PPP STAKEHOLDERS

Earlier studies on stakeholders have classified stakeholders into two groups, namely; Internal/Primary and External/Secondary stakeholders (Harris, 2010; Leung, 2010; Winch, 2010). Leung (2010) point out that, Internal stakeholders are entities with legal contract to the project such as; Government authorities, concessionaires, private investors, consultants among others while external stakeholders are entities with interest in the project but without a contract such as; users, NGOs, media and local communities. Managing stakeholders in PPP is trust based collaborations between the public and private sector towards the achievement of set of objectives (Andriof and Waddock, 2002). Stakeholder's management is a concept that describes an organisations' resolve to manage relationships with its stakeholders group in a proactive manner (Freeman, 1984; Chinyio and Olomolaiye, 2010). The essence of managing relationships is to motivate stakeholders to act in a manner that enhance the successful implementation of PPP projects (Harris, 2010; Amadi *et al*., 2014). Also, governments are responsible to establishing programs and develop the necessary capacity to ensure PPP project success. The way a government shapes the environment for PPP development will depend on the institutional context where projects take place. The policy interventions will have an impact on the institutional capabilities of the environment to foster PPP development and provide an enabling environment (Jooste *et al*., 2011, Castano *et al*., 2012). Apparently, managing PPP stakeholders amidst favourable investment climate and a well-designed institutional and regulatory framework by the government will minimise PPP projects failure thereby enhancing project success

3.1 PPP stakeholders' management

Stakeholders in PPP infrastructure projects are more sensitive and complex that in a typical construction projects (Jayasuriya *et al*., 2016). It therefore requires proactive efforts in managing the various stakeholder's roles and responsibilities in the project (El-Gohary, 2006; Bakhtawar *et al.,* 2018). The stakeholders activities is not only important for addressing the ineffective risk allocation issues in PPP contracts but is also desirable for prevention of opposition and conflicts (Burke and Demirag, 2017). Therefore, to minimise failure in PPP projects, this research developed a conceptual framework for stakeholder's management in PPP projects (see Figure.2). The framework builds on the stakeholder's theory and Yang *et al.* stakeholder's framework (Freeman and Reed 1983; Yang *et al*., 2010), taking into consideration the expectation and roles of different stakeholders. For instance; the public sector in providing a conducive investment environment and institutional and regulatory framework for the motivation of private sectors to invest in PPP infrastructure projects. In figure 2 below. The conceptual framework includes the attributes of investment climate and institutional framework for influencing the private sector participation towards the successful delivery of PPP projects. The framework also takes into consideration the role of trust and communication in enhancing the success of PPP infrastructure projects.

3.1.1 Stakeholder's identification in PPPs

Stakeholders management begin with the identification and collection of information about all involved stakeholders (Internal and external stakeholders) which will be utilise in the subsequent management activities. Identifying the full list of stakeholders will assist to ascertain the stakeholders in the project (Frooman, 1999). Stakeholder's information is important in assessing the stakeholder's involvement in the project. This information includes:

stakeholders contact information, their interest, needs, commitment and constraints to project delivery (Freeman *et al.*, 2007)

3.1.2 Stakeholders involvement in PPP infrastructure Projects

Stakeholder's involvement in PPP infrastructure projects plays a very important role in project delivery. Stakeholder in this context refers to any person or organisation that has a legitimate interest in the implementation of PPP infrastructure project. The involvement of stakeholders in PPP projects is essential because it reduces opposition and help to mobilise necessary resources for project implementation (Klijn and Koppenjan, 2016). Involving and managing stakeholders within a PPP project reduces the opposition from societal or citizens groups. Studies have revealed that major PPP road infrastructure projects in the United State have encountered various problems which eventually led to project failure due to stakeholders' opposition (Levy, 1996; El-Gohary *et al*., 2006). Levy (1996) further state that these failures were mainly because the public was unaware of the concept of PPP, not sufficiently educated about PPP and were denied access to detailed information contained in the consortium PPP proposals. Also, the involvement of stakeholders in PPP projects provides an improvement of content and innovation (Nederhand and Klijn, 2019). Figure 2 presents the grouping.

When private consortia are involved, better innovation and more tailor-made solution are achieved leading to more information, knowledge, ideas, creativity and overall project success (Hodge *et al*., 2010). The engagement of groups or individuals outside the government and private sector as part of the stakeholders to be engaged in consultation at the inception stage of PPP is important to the implementation of PPP infrastructure projects. These groups includes: Communities/ Residents/users, media, labour unions, special interest groups among others.

3.1.3 Stakeholders support in PPPs

Stakeholders' management in PPP project requires continuous support from the initiation to the completion stage. The stakeholders support activities necessary for project success includes; ***a.*** communication with and engaging stakeholders properly and frequently ***b.*** Realising changes of stakeholders' information, influences, relationship and behaviour during the project process ***c.*** Keeping and promoting an on-going relationship with stakeholders. ***d***. Private sector obtaining support and assistance from the public sector by reducing the bottlenecks in the approval processes (Yang *et al.*, 2009).

3.2 Investment climate for Public-Private Partnership

Conducive investment climate has long been recognised as a pre-requisite for attracting investment and thus fostering economic growth. The investment climate is defined as the institutional, policy, and regulatory environment in which firms operate (Emirullah and Azam, 2014). Key determinants of the investment climate include economic and political stability, rule of law, infrastructure, approaches to regulations and taxes, functioning of labour and finance markets, and broader features of governance (World Bank, 2005, Emirullah and Azam, 2014). Investment climate is the institutional and policy environment that influence the involvement of stakeholders such as; local and foreign investors in PPP infrastructure projects. Investment climate is crucial because the private sector would not be interested to participate in a PPP arrangement if the situation in the country is not conducive. Therefore, Emirullah and Azam (2014) posited that, an enabling environment should be established so that private sectors can be compensated with reasonable returns for putting a significant amount of resources which constitute a high degree of risk due to long-term nature of PPP investment.

3.3 PPP Institutional and regulatory framework

The regulation of PPPs in the delivery of infrastructure projects can produce harmful consequences when poorly designed and implemented (World Bank, 2006). A sound

institutional framework conducive to PPPs that ensures government commitment, transparency, predictability, and coherence, is a major determinant of project success and private investor engagement in PPPs (World Bank, 2011; Babatunde, 2015). The government has to do the needful in providing an enabling environment and commercially oriented framework of law and regulation to enable PPPs to flourish (UNECE, 2008). Thus, the legal framework should be well designed to accommodate all stakeholders in PPPs and to protect their rights among others (UNECE, 2008).

3.4 The role of Trust in PPP infrastructure project

Trust is a fundamental factor when building a relationship and it has shown to improve productivity (Wong and Cheung, 2004). Rousseau *et al.* (1998) describe trust as a psychological state comprising the intention to accept vulnerability based upon positive expectation of the intention or behaviour of another. Trust is an efficient way to lower transaction costs in partnership thereby enhancing the successful delivery of PPP projects (Parker and Hartley, 2003). Trust facilitates cooperation as it creates greater predictability and reduces the risk inherent in transaction and cooperative relations (Nooteboom, 2002). Trust has a positive and negative consequence on PPP project performance as lack of trust may cause project failure while the presence of trust will improve productivity and project success. Smyth and Edkim (2007) discover that, many of the critical relationships such as Special Purpose Company (SPC)-Public client relationship are negative and lack trust and confidence, resulting to failure of PPP infrastructure projects.

3.5 Effective Communication among Stakeholders in PPP project

Communication can be seen as an interactive cycle including a sender, receiver, message, media, and a possible feedback (Siering and Svensson, 2012). Communication should not be a one-way processes rather, a two-way process. Clegg et al. (2008) states that communication is an activity to create, shape, maintain relationship and endorsing mutual understanding. It is important to establish a good communication channels with all stakeholders, both internal and external by setting clear communication goals, keeping active involvement and being persistent (Manowong and Ogunlana, 2010). This is corroborated by Bourne (2009) that, it is important to target the communication with the right information in the right way to the specific stakeholders especially the external stakeholders, who are not fully involved in the implementation process.

CONCLUSION

Stakeholder management in PPP infrastructure projects is generally about managing diverse stakes (Internal and external stakeholders). It is a crucial and an important endeavour that can yield maximum benefit to both the public and the private sector; such as improving performance of PPP projects, minimising projects failure, stimulating local and foreign investor's interest in PPP infrastructure projects among others. The study has conceptually rationalised the stakeholders' activities and other influencing attributes as steps in minimising the inherent failures of PPP infrastructure projects. Failure to manage stakeholders can impact negatively on the projects; such as early termination of concession agreements, delays, failures and controversies. The main purpose of this paper is to minimise failure of PPP infrastructure projects; as such the framework has brought together different variables that will improve stakeholder's management in PPPs thereby reducing unforeseen risks, negative actions and reactions that have potential impact upon the project success, thus, when applied will improve the success rate in the delivery of PPP infrastructure projects.

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An Evaluation of the Challenges of Tendering Procedures on Building Projects in Kaduna, Nigeria

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Abstract:

The high tender figure which cannot be justified with the quantity of construction work being quoted for has generated a lot of controversy within the industry and this has constituted a great and living menace in our environment like project abandonment, poor workmanship and completion of work behind schedule. The study aimed at evaluating the challenges of tendering procedures on building projects in Kaduna, Nigeria. The study largely derives qualitative measure in order to understand the challenges of tendering procedures on building projects, the study is a criteria – based study, in which certain criteria were outline for the selection of the construction firms. The respondent (stakeholders) samples used in the study were drawn from the total population of stakeholders in the 5 construction firms selected for the study. The total numbers of stakeholders are 170 while 119 were selected for the study following the rules of Krejcie and Morgan, (1970). The analysis of the questionnaires survey data was undertaken using (SPSS) version 20. Findings from the study shows that the tendering method adopted for a particular project is one of the major contributory recipe for the challenges encountered at post construction contract stage in building projects, and the research recommends that the best and most appropriate tendering method should be adopted for the award of construction contracts as this will help in minimizing the problems that are mostly encountered at post contract stage in construction projects execution in Nigeria.

Keywords: - Building, Challenges, Procedure, Contract, Tendering.

INTRODUCTION

Clients (especially public and cooperate) are more at home to invite and select contractors when a given project is large, complex and specialized. However, these clients often do not consider the above factors perhaps to give credence to "Due process" or the present government policy which seeks to exhibit transparency, competitiveness, accountability and even political maturity.

According to Aliyu, (2005), the rising cost in the construction project or the high tender figure which cannot be justified with the quantity of construction work being quoted for has generated a lot of controversy within the industry and this has constituted a great and living menace in our environment like project abandonment, poor workmanship and completion of work behind schedule. Aliyu, (2005) stated reasons for these to include the following

1. Poor selection of tendering procedure for any given contract
2. The construction projects are awarded to incompetent contractors who at the end cannot execute the work up to the expected/acceptable standard
3. The construction contracts are awarded on a percentage kick – back and cause the project to go through different hands before finally reaching the contractor who is to execute the project principally.

In this case, even part of the estimated cost of the project must have been touched by those greedy people who are at the realm of affairs and thereby rendering the project ill funded which finally leads to abandonment.

According to (Ayeni, 1997) the tendering methods available for use in the award of construction contracts include the competitive and non-competitive tendering method. The

competitive tendering involves an open invitation to all contractors/tenderers/bidders for tendering, while non-competitive involves the invitation of a particular contractor for negotiation due to the nature of the contract and the past records of the very contractor. The reason for this method is to install the emergence of any kind of default from the side of any of the construction team members and the contractors inclusive.

In order to ensure that the purpose of tendering is achieved, a client and or his team of advisers should consider and analyse every contracting firm records with a view to ascertaining her reputation for good gravity workmanship, good record of individual relation, good business record, appropriate size and structure to suit the given project and adequate finance stability and should also ensure that adequate choice of tendering procedure is adopted for the award of contract to competent contractor.

The problem of this research is that wrong tendering procedure is associated with many problems like: It result to considerable and unnecessary waste of time, It lead to the selection of an incompetent contractor, It lead to bankruptcy as the result of selecting in experience contractor, It lead to increasing cost of tender, It is often a times associated with risk, It may lead to petition if wrong analysis is done and this problem poses serious challenges on the contractors which in turn leads to project abandonment, poor workmanship, completion of work behind schedule etc.

Previous studies on tendering procedures focused on the important factors affecting tendering procedures with little or no emphasis given to the problems and challenges of tendering procedure at post contract stage of building projects in Nigeria. Hence, this research aims to examine the challenges and problems of tendering procedures at post contract stage of building projects in Kaduna, Nigeria.

LITERATURE REVIEW

Tendering processes

Tendering is the process of inviting contractors or suppliers to submit bids for the execution, supply or procurement of a given project Odunsami and Ojo, (2005) according to Onifade, (2011) there contains numerous sellers and buyers for the same construction project in the construction contract market. (Skitmore, 2000) noted the commonness of tendering as a method of procuring a lot of dissimilar goods and the worth of the goods exchanged through auctions or tender is large. The normal preliminary to the conclusion of a building and engineering contract is an invitation by the employer to one or more contractors to tender at a price at which they are willing to carry out the works Odunsami and Ojo, (2005) Tendering has also virtuously defined according to Faizal (2010) "Tendering arises when the type of contract appropriate to a given project has been decided and attention turns to the selection of the contractor". The method adopted in the selection and acceptance of a tender revolve on some given criteria which include the nature of the project, lowest evaluated tender, reasonable completion time and client desire.

Tendering as also be defined by (Ayeni, 1997) is the act by which submission is made by a tenderer when so desired by a client which may be individual, a group of people, a company, government ministry or any of its parastatals.

(Aqua group, 1990) stated that a tender quote not just a price, but also a time in which to complete the work. The purpose may not be for one job only but may be considered in terms of the total programme of which that job is just one project.

As a definition, tendering processes refer to the overall methods used by a client so as to arrive at a tender figure.

However, there are other methods through containing some characteristics of each and or combination of the principal methods and these include serial tendering and the all in service.

The following factors are considered before adopting any method of tendering.

1. Nature of the client.
2. Client's wish
3. Cost of the project
4. Duration of the project.
5. If work is to be started before design is completed.
6. Consultants' knowledge or lack of knowledge about the contractors in the locality of the proposed project.
7. The nature of the project that is whether traditional or system building.
8. Any assistance required from the contractor in the early stages of the project.
9. If the project requires the contractor's participation in the design e.g. design and build (Onwusonye, 2006)

Types of tendering processes/methods

Open tendering

Open tendering is one by which the employer advertises his proposed project, and permits as many contractors as are interested to apply for tender documents. Sometimes he calls for a deposit from applicants, the deposit being returned 'on receipt of a bona fide tender'. However, this method can be said to be wasteful of contractors' resources since many may spend time preparing tenders to no effect. Also, knowing their chances of gaining the contract are small, contractors may not study the contract in detail to work out their minimum price, but simply quote a price that will be certain to bring them a profit if they win the contract. Basically open tendering involves simply advertising in the national and or technical press the minimum requirement expected from interested tenderers who must have been legally registered with the cooperate affairs commission (CAC) and the clients' organization to submit tenders (Faizal, 2010).

Selective tendering

Selective tendering, in this type of tendering, the employer advertises his project and invites contractors to apply to be placed on a selected list of contractors who will be invited to bid for the project. Contractors applying are given a list of information they should supply about themselves in order to 'pre-qualify' (Onifade, 2011).

The advantage to the employer is that he can select only those contractors, who have adequate experience, are financially sound, and have the resources and skills to do the work. Also, since only half a dozen or so contractors are selected, each contractor knows he has a reasonable chance of gaining the contract and therefore has an incentive to study the tender documents thoroughly and put forward his keenest price (Onifade, 2011).

Selective tendering as practiced in the past especially for public works procurement remained one of the arms of competitive tendering and used in the vast majority of building and civil engineering contracts Faizal (2010) opined that selective tendering aims at satisfying the client that he has got the best often available.

Basically, selection was exercised either by advertising for firms to indicate their interest (requiring them to supply particulars of their financial and technical capability in appropriate cases) and selecting a short list from those applying or simply by a selection from standing lists of investigated and approved firms and whose capabilities were known at least in general terms.

Negotiated tendering

Negotiated tendering is a specialized form of selective tendering is which encourages a one–name list of tenderer.

(Faizal, 2010) opined that negotiated tendering is restricted to those projects where specialist technical ability prevents or restricts competition or where the client has some overriding reason to employ a particular firm.

Furthermore, institute of builders 1976 submits that negotiation permits early contractors involvement and consequent opportunity for overlap of design and construction, closer integration of construction method/design and resultant saving in overall time.

It follows therefore that there exists a better understanding of problems between the designer and the contractor.

However, the client design for negotiated tending may be on the basis of:

1. Business relationship: the client or the contractor may be a subsidiary company of the other or associated in the same way.
2. Ideology affinity: this happen when an important purpose of the client is the furtherance of some ideology whereby he preferred a contractor who is similarly minded.
3. Loyalty of the locality: this situation arises when the client preferred a contractor who is traditionally connected with the same locality. For example, the decision of a parish council to engage a parishioner contractor to construct a parish hall building. Similarly, the federal government engaging a Nigerian nationality to construct a national prestige/security edifice.
4. Project financing project: this situation is experienced when the building project is contractor financed.
5. Project financing: this is usually common especially on Turnkey, build own operate and transfer, build lease and transfer etc.

Post construction contract tendering challenges/ problems

According to Mccaffer, (2001) and Bamisele, (2005) indicates that lost production time can regularly account for about fifty per cent of the working days, with even higher levels not uncommon. The causes are usually inter connected and typically arise through unsatisfactory execution of managerial and supervisory function surrounding short time planning, daily and weekly scheduling, material standardization and control, information flow, constructability of design, subcontractor and supplier's performance, work goals and competency rather than specifically in the method of working. Indeed, detail information obtained directly from the workforce in the structured questionnaire survey (Sani, 2011) shown below illustrate the kind of problems causing serious construction difficulties which whenever identified will need rooting out and remedies devising:

1. Lack of material due to waste, transport difficulties, improper handling on site, misuse of the specification, lack of proper work plan, inferior or excessive paper work.
2. Excessive whether delays.

3. Equipment breakdown.
4. Drawing and specification changes.
5. Variation orders.
6. Inadequate tools or equipment.
7. Inspection delays.
8. Absenteeism
9. Poor work plan.
10. Repeat work due to poor finishing, negligence, congestion, over complicated drawing and or specification, poor supervision, improper material and poor design or engineering.
11. High labour turn over due to low pay, casual labour, remote site, late pay days, work discontinuities, poor work facilities and lack of materials.
12. Work interference.
13. Poor construction communication.
14. Poor site management and/or organisation

Table1: Problems causes post building construction contracts difficulties

S/No	Categories	Sub – categories
1	Late payment	a- Client's poor financial and business management. b- Withhold of payment by client. c- Constructors invalid claims. d- Delay in valuation and certification of interim payment by consultant. e- In accuracy in valuation of work done. f- In sufficient documentation and information for valuation. g- Involvement of too many parties in the process of honouring certificates. h- Heavy work load for consultant to do evaluation for variation order.
2	Poor cash flow management	a- Contractor handling too many projects at the same time. b- Contractor's unsuitable financial background. c- Unqualified contractor under bidding the project cost. d- Lack of regularly cash flow forecasting. e- Poor credit arrangement with creditors and debtors. f- Capital lock-up
3	Insufficient financial resources	a- Difficulties in obtaining loan form the financiers b- Allocation of government budget not in place.
4	Financial market instability.	a- Increment of interest rate in payment of loan. b- Inflation (material price, labour wages, transportation costs) c- Increment in foreign exchange rate (imported material and plant).

Sources: (Harris and Mccaffer, 2001)

RESEARCH METHODOLOGY

According to Creswell, (2003) that the factor to be consider in selecting the best research methodology should be the influence that such method has on the research problem and objectives. The study largely derives qualitative measure in order to evaluate the challenges of tendering procedures on building projects in Kaduna, Nigeria. The stakeholders considered for this research are the contractors, architects, quantity surveying, civil engineers and builders working within the contractor's organisations. The study is a criteria – based study, in which certain criteria were outline for the selection of the construction firms and their stakeholders. **Those criteria are:**

8. The construction firm must be built/civil engineering, construction.
9. The construction firm must be more than twenty (20) years in civil/building construction work.
10. The construction stakeholders must at least be with the construction firm for not less than fifteen (15) years.
11. His qualification must be at least B.Tech/MSc or HND.
12. The location of the study is Kaduna, Nigeria.

Five (5) construction firms were identified that meet the study criteria and as such five (5) of the construction firms were selected for the study. The selection is based on sample selection rules of Krejcie and Morgan, (1970). The respondent (stakeholders) samples used in the study were drawn from the total population of stakeholders in the 5 construction firms selected for the study. The total numbers of stakeholders that meet the study criteria in the 5 construction companies are 170 while 119 were selected for the study following the rules of Krejcie and Morgan, (1970) formula, the value was reduced to a minimum of 119 at 95% confidence level and at 5% limit of error; showing that 119 is the minimum number of questionnaires that can be administered within the population.

The research questionnaires were administered to 119 permanent stakeholders within the 5 construction firms in Kaduna. The analysis of the questionnaires survey data was undertaken using the statistical package for social science (SPSS) version 20. Which is a software package used for statistical analysis. It is now named "IBM SPSS Statistics". It is manufacture in Chicago USA, by SPSS Inc.

Table 1 shows that 170 respondents were identified within the research population, from which a total of 146 structured questionnaires (on a five-point Likert scale), were administered, and 119 were retrieved with all fully answered and valid for analysis, representing 86% response rate.

Table 2: Sample Frame of the Study

Respondents	Population Size	Questionnaires administered	Questionnaires retrieved and valid for analysis	Percentage rate
Quantity surveyors	50	44	36	32.9%
Architect	40	34	27	14.4%
Contractors	45	39	33	26.4%
civil engineers and builders	35	29	23	12.3%
Total	170	146	119	86%

Source: Researchers' survey, 2019

The collected data were analyzed by using the descriptive methods (percentile and frequency). Data processing was done with the aid of Statistical Package for the Social Sciences (SPSS) software.

The frequency was adopted to determine the level of occurrence (frequently, rarely, not at all) of the identified problems and challenges of tendering procedures at post contract stage of building projects.

RESULTS AND DISCUSSION

Table 3: Frequency of problems and challenges of tendering procedures at post contract stage

S/N	Problems	Frequency			Percentage (%)		
		Frequently	Rarely	Not at all	Frequently	Rarely	Not at all
1	Project abandonment	16	9	1	61.52	34.62	3.85
2	Failure to agree on final account	21	3	2	80.77	11.54	7.69
3	Delay in construction project	24	2	0	92.31	7.69	0.00
4	Cost over-run	8	18	0	30.77	69.23	0.00
5	Liquidation	3	20	3	11.54	76.92	11.54
6	Bankruptcy	4	12	10	15.38	46.15	38.46
7	Poor communication between contractor's and client's team	5	18	3	19.23	69.23	11.54
8	Non-performance of obligation by contractor	8	16	2	30.77	61.54	7.69
9	Non-performance of obligation by client	5	15	6	19.23	57.69	23.08
10	Delayed payment	8	8	10	30.77	30.77	38.46
11	Drastically design change	12	8	6	46.15	30.77	23.08
12	In experience team	15	7	4	57.69	26.92	15.38
13	Accelerated completion	10	8	8	38.46	30.77	30.77
14	Low productivity/out-put	14	5	7	53.84	19.23	26.92
	Total	**153**	**149**	**62**			

Source: Researchers' survey, 2019

Table 3 represents the frequency of occurrence of problems and challenges encountered by the respondents at post construction contract stage in building projects. Project abandonment 61.52%, Failure to agree on final account 80.77%, Delay in construction project 92.31%, Increase in cost of projects (cost over-run) 30.77%, Liquidation 11.54%, Bankruptcy 15.38%, Poor communication between contractor's and client's team representing 19.23% and 11.54% respectively, Non- performance of obligation by contractor 30.77%, Non-performance of obligation by client: 19.23%, Delay in payments 30.77%, Drastically change of design or specifications during construction 46.15%, In-experience management or supervisors 57.69%, Time constraint and/or accelerated completion 38.46% and Low productivity/out-put with a frequency of occurrence at 53.84%.

CONCLUSION AND RECOMMENDATION

The poor selection of tendering procedures has constituted a great problem in the construction environment, especially at post contracts stages of projects executions like projects abandonment, poor workmanship, and completion of work behind time schedule. This is as a result of construction contracts awarded to incompetent contractors whom at the end cannot execute the work up to the expected standard. it could be deduced that the tendering method adopted for a particular project is one of the contributory recipe to the problems encountered at post construction contract stage in building project. These problems include project abandonment, failure to agree on final account, delay in construction project (time over-run),

increase in cost of project (cost over-run), liquidations, bankruptcy, poor communication between contractor's and client's teams, and non-performance of obligation by contractor with liquidation, and non-performance of obligation by client as problems that rarely occurred in construction site.

Given the findings above the study recommends that, all projects within the construction industry no matter what should be awarded to a competent contractors that are capable of carrying out the work for a successful delivery, past record/experience of the contractor should be thoroughly examined by the client to assess the performance of such contractor in his previous contract before awarding the contract., Clients and consultants should only call for tender with complete project documents in order not to make room for contractors to price high to cover unknown risks, lastly, consultants should produce all the necessary drawings that are within the financial whims of the client so as to aid the estimator to come up with an accurate and realistic tender figure to minimize the problems and challenges encountered at post contract stage in building projects in Nigeria.

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SUB-THEME 5:
SUSTAINABLE AND RESILIENT CITIES

Integration of Passive Energy Efficient Design Elements for Office Complex, Abuja, Nigeria

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Abstract:

Energy necessity of buildings has seen an increase over the past years. Predominantly is the demand for cooling and lighting of buildings. The commercial sector has been identified as one of the major contributors to the immense diminishing of natural resources through the use of artificial energy for cooling and lighting of buildings. The study integrates passive energy efficient design elements to achieve sustainable energy efficient office buildings in Abuja, Nigeria. The research adopted descriptive survey method as it permits for multi-dimensional approach to data collection. Qualitatively, the extent at which passive design elements such as building orientation, courtyard, building form, thermal insulation, and skylight have enhanced energy efficiency was determined. Through stratified random sampling, ten (10) office buildings were selected across the city of Abuja to observe the energy efficient design elements adopted in them. Data was collected through observation schedule and well-structured questionnaire. Data collected was statically analyzed and the result showed that office buildings in Abuja were designed with little consideration for passive design elements as most of the office buildings depend on mechanical means for lighting and cooling. It is recommended that passive design elements should be considered in future office design to reduce energy requirements and the negative effects it might have on the environment.

Keywords: design strategies, Energy efficiency, Office buildings, Passive cooling, and Passive lighting

INTRODUCTION

Energy required by buildings has seen an upsurge over the past decades, predominantly is the energy demand for lighting and cooling of buildings. The artificial means used for improving energy needs of buildings lack credibility in terms environmental sustainability (Hyde, 2017). Passive design elements such as orientation and form of the building, radiant heat transfer, evaporative cooling, can be used to attain energy efficiency in buildings (Gokarakonda, and Kumar, 2016). These means have passed the conditions for sustainability. Reduced environmental impact and resource intake are some of the advantages linked to these passive energy efficient strategies (Peter, 2015). Bassler *et al.* (2015) identified that energy saving is locally designing for energy management which aims to curtail the use of conventionally driven ventilation, heating, and lighting by complementing natural energy obtainable at the building site. In tropical areas like Abuja, the major usage of energy in office buildings is for ventilating, lighting and running services such as lifts operation, refrigeration and office equipment. Embracing passive strategies will lead to reduced energy required by the buildings.

Passive cooling can be attained through numerous design methods such as the use of sun shading devices, courtyards, laminated windows, and landscaping. Courtyards also function efficiently in lighting interior areas. Sky lights and large openings are other inactive means of achieving day lighting in buildings (Anink et al, 2010). The word office can be seen as any building that fits into a suitably zoned unit, block and lot as recognized by statutory authorities for commercial purpose. The concept of an office differs, but best characterized by the building design guides by what spaces it encloses. According to WBDG (2009), a characteristic office space may include an office

work space, integrated meeting space, work rooms, core office support space, storage rooms, file rooms, mail rooms, conferences, copy areas, telephone, mechanical and communication equipment rooms, fitness, store, cafeteria, childcare, packing.

Commercial buildings like office buildings have been recognized as one of the main contributors to the decreasing ecological resources (Lam *et al.*, 2011). Researches show that office buildings account for a significant amount of energy consumed by buildings in many parts of the world including Abuja. This energy consumption if not tamed can lead to global warming through the release of harmful gases like greenhouse gas into the environment. Dependence on mechanical means of lighting and cooling office buildings have generated numerous environmental challenges (Oyewunmi, 2016). This study is aimed at integrating energy efficient design strategies to provide eco-friendly office buildings in Abuja, Nigeria.

The Concept of Passive Design Strategies

Following the rise in awareness about global heating and the reliance of built environment on energy for everyday activities, sustainability is progressively being stressed around the world. Occupants of buildings are now more aware of the significance of sustainability for an improved quality of life (Sambo et al, 2014). Energy is necessary for buildings' activities. Lighting, ventilation, insulation, and controls have been enhanced and these are significant features to achieve energy efficiency. Energy efficient Passive design strategies, such as thermal mass, cross ventilation, external shading, building orientation, and insulation in buildings, are the components of sustainable building (Wimmer et al, 2013).

Passive Design Strategies

Passive Design refers to actions put in place to create a building by means of natural movement of heat and air in order to preserve a good internal environment (Gokarakonda, and Kumar, 2016). Passive design includes collection, storage, and distribution of energy movement through natural means. The main objective of passive design is to lessen or remove the need for active motorized systems while preserving occupants comfort (Hyde, 2018). Some of the passive design strategies are discussed below.

Passive design by orientation refers to how a building is positioned on site to take benefit of climatic features (McGee, 2013). West and east facing walls get the highest amounts of radiation. The best form and orientation in the tropics is rectangular with the long axis running east-west to curtail solar heat gain (Yamba, 2013). In addition, Overhangs and shadings aid in curbing overheating (Tin – Tai, 2017). They should be correctly sized on the building facade to ensure suitable shading.

Buildings need to be sufficiently insulated in order to hold heat in winter and keep the cool throughout summer. Insulated materials are bad conductors of heat, they also form a barrier between interior and exterior spaces, and serve to preserve warmth in cold season between interior and exterior (Santamouris, 2007). More so, windows and doors have significant functions in allowing in natural light and air. However, in the tropics, they are the main causes of unwanted heat gain (McGee, 2013). The perfect design would have only south and north windows and fewer or no east or west windows (Lechner, 2014).

Also, evaporative cooling reduces indoor air temperature through evaporating water. In dry climates, this is usually done directly in the space. But indirect approaches, such as roof pools,

permit evaporative cooling to be used in more temperate climates. Ventilation and evaporative cooling are often complemented with mechanical methods, such as Air conditioners. They use noticeably less energy to preserve comfort when compared with refrigeration systems (Brown and Dekay, 2011).

In summary, consumption of energy is a vital element of development. While energy use obviously has numerous benefits which include; reduced Life-cycle Costs (Pitts, 2017), minimized resource consumption (NCR, 2015, Francis et al, 2011), lessened environmental effect (IEA, 2018), improved indoor environment (Young et al., 2015), emissions and health benefits (U.S. EPA, 2017), we are also becoming progressively conscious of the negative effects of energy use (Yamba, 2016). We experience these bad effects universally and locally in the form of poor air quality, climate change and degradation of soils.

METHODOLOGY

The descriptive method of survey was adopted in carrying out this research. This is because it allows for detailed information which permits for many-sided approach to data gathering and examination. This method was used to assess design strategies for energy efficiency in office buildings. The main passive design elements examined include day lighting, evaporative cooling, building form, natural ventilation, orientation, landscaping and thermal mass. An investigation was done on the office buildings examined to determine the degree to which passive cooling and lighting building elements were adopted in their designs, and also to examine how satisfied or dissatisfied the occupants of the buildings are with the passive elements used. This examination was done through critical observation and post occupancy evaluation of the design elements adopted in the design of the sampled office buildings.

Qualitatively, users' perception was analysed through post occupancy evaluation and with the aid of questionnaire. These were used to determine their level of satisfaction with energy efficient design elements adopted, these elements includes; courtyard sizes, windows opening sizes, quality of natural lighting and ventilation, and orientation of the buildings. Direct observation through the use of an observation schedule was done on the sampled office buildings to determine whether passive design elements such as evaporative cooling, courtyard, skylight used were adopted appropriately and in good proportion.

Stratified random sampling was employed. This divides the population into smaller strata based on shared characteristics. High rise office buildings were selected due to their extended need. Ten office buildings were selected across Abuja city. SPSS was used to scrutinize the data derived from the questionnaires and observation schedules. Likert scale was used to examine the users' perception of the energy efficient elements used on the sampled buildings.

DATA ANALYSIS

Here, the results of the analysis of data collected are presented. These results and consequences are presented based on the goal drawn in the introductory part of the research work.

Building form for energy efficiency

The form of a building has effect on the energy required by the building. In the tropics where reduction of the effect of the heat on buildings is a major design concern, rectangular forms are encouraged. The impact of the sun on the buildings is minimized as such, they require less energy when compared to circular and oval forms. As shown in figure 4.1, 90% of the office buildings

studied were rectangular in shape, as such the effect of the sun on the buildings is concentrated on one side of the buildings and making the other sides to keep their cool. 10% of the sampled buildings are circular and oval shaped this has effect on the building because the sun acting on the building tends to spread round the building due to the shape and therefore making all building sides to be exposed to sunlight, leading to non-efficiency of energy.

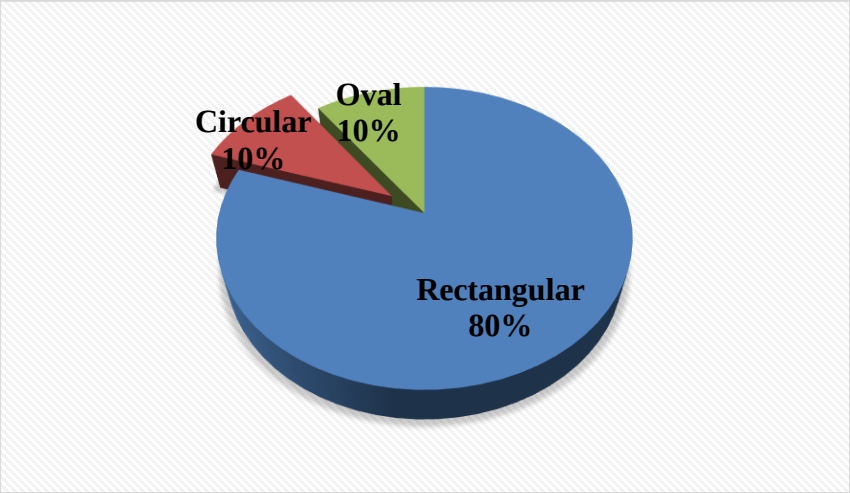

Figure 1: present the form of office buildings in Abuja.
Source: Researcher's fieldwork, 2019.

Building orientation towards energy efficiency

A key factor of the impact of the sun on a building is orientation. Another key determinant of the impact of the sun on a building is its orientation. How buildings are positioned on site with regards to the position and path of the sun have direct impact on the amount of heat the building receives during the day. To minimize heat, it is encouraged that the longer parts of the building do not face the east or west directions. Sun rises from the east and sets in the west. Its effect is felt more along that path. Table1 shows the positioning of the sampled office buildings on site.

Table 1: Orientation of Office Buildings.

S/N	Name of building	Orientation with respect to sun rise and sun set	Position of building on site
1	NNPC Towers	North-West	Obeys to lessen heat gain
2	Churchgate	North-South	Obeys to lessen heat gain
3	Metro Plaza	North-South	Conforms to cut heat gain
4	Bank of Industry	East-West	Does not follow to cut heat gain
5	World Trade Centre	North-South	Follows to cut heat gain
6	IGI building	North-South	Follows to decrease heat gain
7	FIRS Building	North-South	Conforms to decrease heat gain
8	NCC Building	North-South	Obeys to lessen heat gain
9	ITF House	North-South	Conforms to lessen heat gain
10	FERMA Building	North-South	Follows to decrease heat gain

Source: Authors' Fieldwork, 2019.

It is observed that most of the office buildings examined are oriented properly with the longer side facing the north-south direction and having larger windows while the west-east side of the buildings have shorter sides with smaller windows to reduce the effect of sunlight on the buildings. Only a few do not conform to this, as such do not obey to lessen heat gain.
Table 1 shows that all the buildings studied except Bank of Industry are oriented to North-South to decrease the quantity of heat on the building.

Landscape elements from the sampled buildings
Introduction of flora in the design of environments and building surroundings help to prevent solar radiation and improve temperature regulation. According to figure 4.3, the main element employed in the sampled buildings was shrubs, trees and ground covers. Water, shrubs and trees have been used to cool the buildings examined, though these landscape elements are good but were not used appropriately. 5% of the sampled office buildings have made use of water for cooling the building; about 39% of the buildings have used ground covers while 24% used trees to keep the environment cool. In summary, the landscape elements adopted are not used in their sufficient amount and thereby are not energy efficiency.

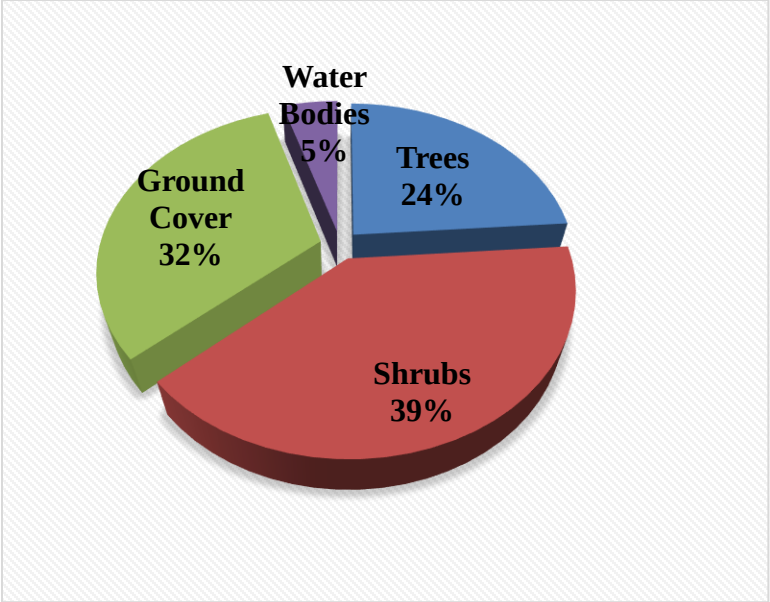

Figure 2: Soft Landscape Elements used in the case study buildings.
Source: Authors' Fieldwork, 2019.

Energy efficient natural ventilation
This is significantly influenced by the size and positioning of openings in a building. According to Figure 2, it was observed that most of the buildings adopted operable window on glazed walls which allows also for maximum lighting but have effect on the heat gain of the buildings. Courtyard was also adopted in some of the buildings to cater for lighting of the interior spaces.
The windows used sum to 56% of the total wall area which is adequate enough for effective ventilation. 50% of the buildings studied can be ventilated naturally, though they are supplemented with artificial ventilation.

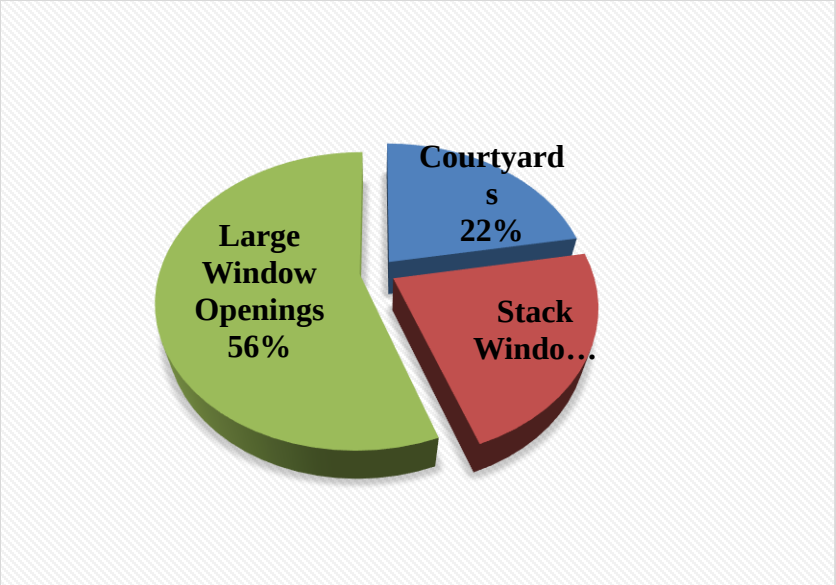

Figure 3: Natural Ventilation design elements used in the case study buildings.
Source: Authors' Fieldwork, 2019

Occupant satisfaction evaluation in office buildings, Abuja

Questionnaire was disseminated to occupants and staff of the sampled buildings. The following data was collected and analysed.

The 4 – Likert scale measurement was used to scrutinize the perception of the users of the office buildings. A score scale of 1 – 4 was used to test the respondents as stated below:

Very Dissatisfied (VD) 1
Dissatisfied (D) 2
Satisfied (S) 3
Very Satisfied (VS) 4

Table 2: Number of respondents per opinion on satisfaction level with Passive energy efficiency design elements.

Key	Variable	Very Dissatisfied	%	Dissatisfied	%	Satisfied	%	Very Satisfied	%	Total
Lp01	Position of building relative to sun movement.	24	11.5	33	15.8	62	29.7	90	43.1	209
Lp02	shading devices	53	25.4	88	42.1	46	22.0	22	10.5	209
Lp03	Natural ventilation	39	18.7	81	38.6	63	30.1	26	12.4	209
Lp04	Natural lighting	32	15.3	45	21.5	63	30.2	75	35.9	209
Lp05	Openings sizes	25	12.0	39	18.7	102	49.0	43	20.6	209
Lop6	Size of interior spaces	50	23.9	76	36.4	44	21.1	39	18.7	209
Lp07	Size of exterior open spaces	47	22.5	81	38.8	36	17.2	45	21.5	209
Lp08	Amount of vegetation	82	39.2	74	35.4	41	19.6	12	5.7	209

Source: Authors' fieldwork, 2019

Multiplying the number of respondent in each section by the given score it gives the total in 3 below.

Table 3: Sum and interpretation of occupants' satisfaction level with Passive energy efficient design elements.

Key	Variable	VD (X1)	D (X2)	S (X3)	VS (X4)	Sum	Mean	Interpretation
Lp01	Position of building relative to movement of the sun.	24	66	186	360	636	3.04	Satisfied
Lp02	Sun shading devices	53	176	138	88	455	2.2	Dissatisfied
Lp03	Natural ventilation	39	162	189	104	494	2.36	Dissatisfied
Lp04	Natural lighting	32	90	189	300	611	2.92	Satisfied
Lp05	Size of Window Openings	25	78	306	172	581	2.77	Satisfied
Lop6	Size of interior spaces	50	152	132	156	490	2.34	Dissatisfied
Lp07	Size of exterior open spaces	47	162	108	180	497	2.37	Dissatisfied
Lp08	Amount of vegetation	82	148	123	48	401	1.91	Dissatisfied

Source: Authors' Fieldwork, 2019

The results interpretation based on 4-Likert scale are as follows:

1.0 - 1.49 Very Dissatisfied
1.5 - 2.49 Dissatisfied
2.5 - 3.49 Satisfied
Above 3.5 Very Satisfied

As deducted from Table 3, majority of the respondents are contented with the placing of the buildings, natural lighting and the size of openings. However, they expressed displeasure with the other variables which include size of interior spaces, sun shading devices, natural ventilation. Amount of vegetation records the lowest satisfaction level. They were mostly satisfied with the position of the building with regards to movement of the sun. This implies that sun shading devices, amount of vegetation natural ventilation, need to be improved upon.

FINDINGS

The analysis showed that designers do not properly integrate passive design elements in office buildings design due to the non-functionality of the ones studied in the sampled buildings

About 36% of office buildings have adopted these passive design elements. However due to their inappropriateness, they are complemented with other sources of energy which are harmful to the environment.

It is discovered that some office buildings in Abuja require large energy for cooling and lighting due to the fact that the passive design elements were not adopted in their designs. However, these energies have negative effects on the environment.

CONCLUSIONS

The concept of passive energy design proposes using design strategies to decrease reliance on artificial. As analysed, it was noticed that the occupants of the sampled office buildings were displeased with most of the energy efficient elements adopted in the buildings. They were mostly dissatisfied with the vegetation and other landscape elements. Sun shading devices recorded low score value. Passive cooling elements used comprised laminated window, overhangs, shading devices and interior gardens. 56% of the buildings observed used large windows, 22% used courtyards and 22% adopted stack windows for lighting and ventilation.

It is recommended that designers and developers in the built environment should clinch to passive design strategies to reduce reliance on artificial means. Also stakeholders in the built environment should provide awards for designers who design outstanding sustainable buildings.

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Liveability of Public Housing in Nigeria: A Study of Residents' Satisfaction in Some Selected Public Housing Estates in Niger State

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Abstract:
Housing is one of the basic human needs and it is made up of a residential environment comprising the physical structure for shelter, all necessary services, facilities, and equipment including devices needed/desired for the physical and mental health as well as social wellbeing of the residents. Liveability in public housing takes into account the composition of the many qualities that make it a place where people want to live. This study aims at assessing the liveability of housing estates through an evaluation of the residential satisfaction of the public housing environments in the study area. Multi-stage cluster sampling was first employed to select the study locations while random sampling and systematic random sampling techniques were used in the selection of housing estates and units respectively. The main instrument used for data collection was Questionnaire of which a total of 910 copies made up of questions on 74 liveability variables drawn from literature were administered out of which 797 were returned. The socio-economic characteristics of residents was computed using frequencies and percentages while satisfaction rating of variables with the aid of SPSS was computed to determine the users' evaluation of liveability elements of the environment. The analysis indicated that the housing units were altered from the original design as 73% of the residents have done one change or the other. Also, the lowest dissatisfaction of 2.49 was expressed on the housing estate spatial level while other spatial levels of housing unit (2.88) and housing estate neighbourhood (2.72) were slightly above the 2.5 threshold. The design or upgrade of the housing estates therefore, requires greater attention on the components of Public facilities and Security, Management, Land use & Relationship in housing estates. The research will help public housing providers to understand the occupants' experience & evaluation thus contributing to achieving liveable housing estates.

Keywords: *Liveability, Housing, Residential, Satisfaction, Environment,*

1.0 INTRODUCTION

Housing which is one of the basic human needs is a residential environment composed of the physical structure for shelter, all necessary services, facilities, and equipment including devices needed or desired for the physical and mental health as well as social wellbeing of the residents (Ibimilua&Ibitoye, 2015). So housing takes into account all the social services and utilities that go to make a residential environment a liveable environment. However, Nigeria being one of the fastest urbanizing countries in the African continent (Ezeigwe, 2015), has had its share in urban problems as a result of the growth and physical expansion resulting into

Poor housing and unplanned urban sprawl, environmental pollution, deterioration, deficiencies in modern basic facilities, and general urban decay. Therefore, housing issues amongst the other attendant problems of urbanization have been negatively impacted, leading to housing sector in the country with very poor housing conditions.

Public housing provisions in Nigeria dates back to the colonial era (Ibimilua & Ibitoye, 2015) and are residences for staff by either federal, state or Local governments. However, despite efforts of successive administrations, Ibimilua and Ibitoye (2015) noted that the issue of housing provision in Nigeria is generally bedevilled with a lot of problems amongst which is the unguarded urbanization resulting from the enormous rural to urban migration. This, as a consequence, has given rise to a huge demand for public housing in the urban areas and thus leading to the incidences

of poor housing conditions. In the same vein, efforts by successive governments at addressing public housing provision in Niger State have not successfully solved the housing provision issues since the creation of the state in April 1976 (Niger State Report, 2007). This is attributed to amongst others the continuing rural-urban flow of people especially civil servants. It is clear that urbanization resulting from the enormous rural to urban migration is one of the many challenges in the provision of liveable public housing in Nigeria; and as a consequence, there is a huge demand for public housing in the urban areas (Vision 2020, 2009).

Lowe *et al.* (2013) described a liveable place to be that space which is safe, attractive, socially cohesive and inclusive, and environmentally sustainable; with affordable and diverse housing linked to employment, education, public open space, local shops, health and community services, and leisure and cultural opportunities; via convenient means of transportation. Liveability study of a residential environment looks at the suitability of that environment for human living (Carr *et al.*, 2011). Liveability is thus a reflection of the wellbeing of residents of a residential environment and is made up of the many qualities that make the environment a place where people want to live now and in the future. In creating liveable environments the architects play important role as their design affects the safety and health, as well as the quality of life in the environment (American Institute of Architects, 2005). So studies on Liveability is increasingly becoming very important as it captures the interests of public officials and policy makers around the world as a substitute tool for making decisions on the implementation of the design, planning, and construction of urban environments (Carr *et al.,* 2011). Also as noted by Li (2013) that liveability research is a bridge that links environment users and environment creators including policy-makers, developers, planners and architects, and can help environment creators understand users' experiences and demands through their feedback. These can result in creating living environments that are suitable for the residents to live in; and so residents do not necessarily have to put changes to the built environment in order to make such places suitable to live in. This study therefore aims at assessing the liveability of housing estates through an evaluation of the residents' satisfaction with the public housing environment and services in the study area. This will contribute to research in first providing theoretical basics in liveability study; and secondly providing precepts for future planning and design of public housing in urban areas in Nigeria.

LITERATURE REVIEW

The Concept of Liveability in Housing

The concept of liveability according to Schomberg*et al*, (2011) has become an important topic that has taken the interest of public officials and policy makers around the world as another tool for making planning decisions, since to them, liveability encompasses a broad series of issues which are underscored by a general set of lead principles such as participation, equity, and accessibility. Carr *et al* (2011) defined liveability to simply mean "suitability for human living". Liveability therefore, implies the attributes and features which give a residential environment that desirable quality of life for the residents in that given locality such that the environment is conducive to comfortable living.

The perceptions of liveability of a residential area vary from place to place because of the different views about the dimensions and indicators that should be included to capture the concept of liveability which according to Leby & Hashim (2010) stem from the different research objects and

disciplinary perspectives. This is corroborated by Lowe *et al.* (2013) that there are many ways to measure liveability and that the intent of measurement determines the choice of indicators/indices. Earlier, Omuta (1988) had stated that the liveability of the place is expressed in the environmental issues which are made up of a combination of several of mental perceptions that translates directly into spatial expression grouped into employment dimension, housing dimension, amenity dimension, educational component, nuisance dimension, and socio-economic dimension. The extent to which these criteria have been satisfied determines the quality of the local environment and by extension the liveability of the environment. However, the Principles of liveability in the design of the environment explain the manner in which the indicators which make a built environment healthy are put together. These principles are used as an assessment or evaluation of the liveability of an area and they comprise Connectivity, Sustainability, Accessibility and Flexibility. On the other hand, the residential environment is experienced by the inhabitants from different perspectives which are termed dimensions in liveability. These liveability dimensions provide the content for indicator development by breaking the buildings & built environment into measurable attributes. The dimensions include Social Environment, Physical Environment, Safety and Crime, Functional Environment, Vitality Dimension, Sense and Perception, Fit Dimension, Access Dimension, and Control and Ownership.

Liveability study in Nigeria

Ibiyemi & Adenuga (2013) undertook an evaluation of housing conditions and liveability in Phase One, Festac Town Housing Estate, Lagos, Nigeria using the condition of buildings, internal building amenities, estate physico-social infrastructure, and residents' affordability as measuring parameters. Omuta (1988) had grouped environmental issues of livability into employment dimension, housing dimension, amenity dimension, educational component, nuisance dimension, and socio-economic dimension; while Asiyanbola *et al*, (2012) also stated that the problem of liveability is exemplified in increasing environmental deterioration which is a reflection of poor management comprising the administration of city activities and the ability to anticipate future changes. Lawanson, Salau, and Yadua, (2013) stated that Africans view liveability from the perspective of access to basic necessities of life and affordabilityusing the conceptual framework of the city as a living organism which is dynamic and continually recreates itself for the benefit of her citizens. Also, Mohit & Iyanda (2015) undertook the study of city liveability and housing in Nigeria taking a case study of some low-income housing in Niger State and examining the quality of life with respect to the living environment in the housing estates using six dimensions for the analysis including "Socio-economic characteristics, Economic vitality, Housing characteristics, Safety situation, Neighbourhood facilities, and Social interaction".

Public Housing Evaluation

Housing satisfaction study is one out of many approaches to evaluation of public housing with others including post occupancy evaluations (POEs), evaluation of quality and adequacy of housing approaches (Xiaoyu, Jian, Fei & Hokao, 2007). Housing satisfaction is a multi-layered concept which according to Akindele, Ojo, and Abolade, (2014) defines the gap between respondents' needs and aspirations concerning housing and the reality of the current residential context. It is believed to give the prevailing housing situation because it measures the degree of contentment experienced by an individual or family. Waziri, Yusof & Abd Rahim, (2014) relates

housing satisfaction to how a consumer of housing product reacts to the overall components of such product in response to their expectations. Housing satisfaction is equally seen as the degree to which the inhabitants feel that their housing is helping them to achieve their goals. Also, housing satisfaction is a concept that can be influenced by both objective and subjective measures of housing attributes (Waziri *et al.*, 2014). The objective attributes are determine by the overall housing components while the subjective measures are concerned with psychological aspects and measure perception, emotions, attitude and aspirations which can be determined by age and other social factors (Waziri *et al.*, 2014). In their research, housing satisfaction was measured based on four main components of housing satisfaction in relation to age groupings. These four physical attributes are; structural components, dwelling features, neighbourhood facilities and management services.

Salleh, (2008) identified the reasons residential satisfaction has been a major and popular research topic to include firstly being recognized as important component of individuals' quality of life; and secondly because it affords individuals' evaluations of housing and neighbourhood which helps determine the way they respond to residential environment thus serving as the basis for public policy feedback. The above shows that the knowledge about factors that shape residential satisfaction is critical for a better understanding of household mobility decision process. The study of Salleh, (2008) is hinged on residents' decision about residential conditions which is based on their needs and aspirations. It sees residents' satisfaction with their residential conditions to indicate the absence of complaints as their needs meet their aspirations. On the other hand, the residents are likely to feel dissatisfied if their housing and neighbourhoods do not meet their residential needs and aspirations. Salleh, (2008) concludes that the lack of knowledge on the determinants of residential satisfaction results into the failures of many housing and dwelling projects because residential satisfaction reflects the degree to which individuals' housing needs are fulfilled.

MATERIALS AND METHOD

Data collection

The main Instrument used for data collection was the Questionnaire which contained questions based on the liveability indicators and dimensions established from the literature and consisted of two parts. The first part is for Personal Data & General Information. The demographic features included gender, age, level of education, household size and residential environment features of respondents included the dwelling unit's Size, Type of tenure, Length of residence, and Former housing type. The second part is Data on Residential Environment—this consisted of questions on satisfaction evaluation of the residential environment and constructed on a three-level hierarchy structure of Housing Unit (HU), Housing Estate (HE) and Housing Estate Neighbourhood (HEN) based on liveability variables identified at each of the spatial level. The content reliability of the questionnaire which was constructed in four basic sections was examined by Cronbach's alpha. The reliability values show 0.758 for Respondents Characteristics and 0.871 for Housing Unit; while 0.890 and 0.892 are for Housing Estate and Housing Estate Neighbourhood respectively. All the values were above 0.70 Cronbach's alpha minimum indicating that the questions under each section were adequate.

Sampling Technique

The sampling technique for the study was first a multi-staged cluster sampling. The first stage involved the grouping of the study area into three clusters in line with Independent National

Electoral Commission (INEC) senatorial division of Niger State. This resulted into Niger South, Niger North and Niger East clusters. The second stage clustering was having all Local Government Areas (LGAs) in each cluster grouped together, and then selecting one town which is a local government headquarters as well as having the highest number of housing estates. This resulted in the selection of Minna, Bida, and Kontagora.

In the selection of housing estates within each of the locations, a random selection of the number required was carried out at each point from the list of estates with highest number of housing units and the housing units were fully completed & occupied at the time of study. In Minna this resulted into (i) M.I.Wushishi Housing Estate; (ii) Old Airport/123 Quarters; (iii) Bosso Estate; and (iv) Bosso Lowcost (comprised both Bosso Lowcost Housing & Bosso Senior Staff Quarters). In Kontagora the estates were the (v) State Lowcost Kontagora and the (vi) Federal Lowcost Kontagora; while in Bida the housing estates were (vii) State Lowcost Opposite Ilorin Garage, and (viii) State Lowcost Baddegi Road Bida. The selection of housing units within the selected housing estates was done using a systematic random sampling technique whereby the 1st, 3rd, 5th and 7th selections were done alternately along and across the streets until the entire housing estate was covered in each case. In all a total of 910 copies of questionnaire (one per household) were administered out of which 797 were returned and used for the analyses covering 4 housing estates in Minna and 2 each in Bida and Kontagora.

Data Analysis

The data from the field exercise were analysed into frequencies of variables and satisfaction rating of variables with the aid of Statistical Package for Social Sciences (SPSS).

RESULTS AND DISCUSSIONS

The housing estates were represented as (i) MIWM-(M I Wushishi Housing Estate Minna);(ii) OAQM-(Old Airport/123 Quarters Minna); BLM-(Bosso Lowcost Minna (iv) BEM-(Bosso Estate Minna); (v) SLKG-(State Lowcost Kontagora); (vi) FLKG-(Federal Lowcost Kontagora); (vii) SLIB-(State Lowcost Opposite Ilorin Garage Bida); (viii) SLBB-(State Lowcost Baddegi Road Bida).

The Socio-Economic Characteristics of the Occupants

The level of literacy amongst the respondents is quite high as 14% and 85% have secondary and post-secondary education respectively. The tenure of respondents in the housing estates indicated that majority (70%) of them owned the houses. The Length of Stay in the House shows 95% of the residents have spent at least two years and above in their houses. 90% of respondents have at least one car. 4% of the houses have 1-2 persons living in them, while 3-4 persons live in 19% of the houses and the remaining 26%, 24%, and 27% have 5-6, 7-8, and above 9 occupants respectively. The changes carried out on the housing units indicated that as much as 73% of the residents have done certain changes on their houses.

Determine the users' evaluation of liveability elements of public housing in study area

The evaluation was done through the assessment of the satisfaction of residents with the housing and the residential environment features across all the housing estates represented by Average Weighted Mean (WtM) of the responses. The analysis was done in three (3) parts according to the spatial levels into which the residential environment is divided. These included the Housing Unit (HU) with its 33 liveability elements; the Housing Estate (HE) with its 16 liveability elements; and

the Housing Estate Neighbourhood (HEN) with its 25 liveability elements as shown in tables 1, 2 and 3.

Housing Unit (HU)

The housing unit comprised of five basic components as indicated below with 33 liveability elements identified: (i) *Sizes of spaces*—Size of Plot; Living area; Dining area; Kitchen; Bedrooms; Storage; Setback for Outdoor activities; Distances between the Houses; Distance of house from Road. (ii) *Physical quality of Building*—Floors; Walls; Windows; Doors; Ceiling; Roof; Toilet provision. (iii) *Ventilation and Natural Lighting*—Natural Ventilation in Liv/Din; Bedrooms; Kitchen; Natural Lighting in Liv/Din; Bedrooms; Kitchen; Toilets/Bathrooms. (iv) *Noise Sources*: Vehicular Noise; Noise from adjoining Buildings; Equipment Noise; Neighbours Activities. (v) *Affordability*—Property Cost; House rental; Water rates; Electricity bills; Land use Charge rate; Public Transport cost.

Table 1: Resident Perceived Satisfaction of the Housing Unit (HU)

S/no	LIVEABILITY VARIABLES	MIWM	OAQM	BLM	BEM	SLKG	FLKG	SLIB	SLBB	TOTAL
		WtM	WtM	WtM	WtM	WtM	WtM	WtM	WtM	WtM
1	Plot	2.86	3.20	3.01	2.89	3.13	3.32	3.02	2.49	**2.99**
2	Living Area	3.03	3.45	3.13	3.07	3.70	3.35	2.78	3.00	**3.19**
3	Dining Area	2.65	3.02	2.81	3.03	3.12	3.22	3.15	2.78	**2.97**
4	Kitchen	2.88	3.11	2.88	3.00	3.09	3.22	3.03	2.76	**3.00**
5	Bedroom	3.07	3.35	2.99	3.08	3.16	3.23	3.20	3.27	**3.17**
6	Storage	2.73	2.96	2.90	2.86	3.14	3.20	3.22	3.00	**3.00**
7	Setback for Outdoor Activities	2.69	2.74	2.78	2.72	3.10	3.10	3.20	3.00	**2.92**
8	Distance between Houses	2.68	2.94	2.88	2.79	3.16	3.19	2.86	2.31	**2.85**
9	Distance of House from Road	2.70	3.00	2.98	3.01	3.47	3.24	2.75	2.98	**3.02**
10	Floors	2.44	3.14	2.95	2.97	3.17	2.97	2.02	2.29	**2.74**
11	Walls	2.19	3.06	3.01	2.99	3.71	3.14	2.02	2.29	**2.80**
12	Windows	2.56	3.16	3.06	2.94	3.13	3.22	2.83	2.33	**2.90**
13	Doors	2.50	3.20	3.05	2.97	3.14	3.19	2.24	2.53	**2.85**
14	Ceiling	2.38	3.11	3.05	3.13	3.05	2.95	2.17	2.04	**2.74**
15	Roof	2.52	3.09	2.99	2.85	3.09	2.86	2.48	2.27	**2.77**
16	Toilet Provision	2.63	2.85	3.33	2.93	3.49	2.82	2.80	2.49	**2.92**
17	Vent. in Living/Dining	3.02	3.07	3.06	3.12	3.04	3.22	2.78	2.69	**3.00**
18	Vent. in Bedrooms	3.10	3.06	3.02	3.06	3.31	3.36	2.93	2.98	**3.10**
19	Vent. in Kitchen	2.81	2.81	2.85	3.03	3.10	3.33	2.98	3.20	**3.01**
20	Lighting in Living/Dining	3.01	2.92	3.01	3.08	3.19	3.21	3.00	3.20	**3.08**
21	Lighting in Bedrooms	3.08	3.22	3.03	3.21	3.16	3.29	3.00	2.69	**3.09**
22	Lighting in Kitchen	3.04	2.99	3.03	3.14	3.15	3.28	3.00	3.00	**3.08**
23	Lighting in Toilets/Bathrooms	2.93	3.05	3.02	3.10	3.22	3.21	3.00	2.56	**3.01**
24	Vehicles	2.83	2.54	2.66	2.63	2.67	3.05	2.37	2.49	**2.66**
25	Adjoining Buildings	2.75	2.63	2.55	2.65	3.19	3.04	1.39	2.22	**2.55**
26	Equipment	2.85	2.62	2.46	2.66	3.18	3.09	2.15	2.47	**2.69**
27	Neighbours Activities	2.97	2.83	2.70	2.69	3.18	3.13	2.78	2.76	**2.88**
28	Property Cost	2.63	2.50	2.68	2.79	2.97	3.03	3.12	2.42	**2.77**
29	House Rental	2.56	2.62	2.60	2.63	3.14	3.08	3.36	2.96	**2.87**
30	Water Rates	2.28	1.98	2.40	2.20	2.64	3.05	2.98	2.49	**2.50**
31	Electricity Bills	2.57	1.95	2.31	2.23	2.31	2.92	2.37	2.96	**2.45**
32	Land Use Charge Rate	2.62	2.40	2.64	2.83	3.04	3.00	2.98	2.67	**2.77**
33	Public Transport Cost	2.50	2.38	2.59	2.54	3.03	3.04	3.20	2.96	**2.78**
	TOTAL	90.06	94.95	94.41	94.82	103.37	103.55	91.16	88.55	95.11
	MEAN	**2.73**	**2.88**	**2.86**	**2.87**	**3.13**	**3.14**	**2.76**	**2.68**	**2.88**

Mean	Interpretation
1.0 -.1.49	Very Dissatisfied
1.5 - 2.49	Dissatisfied
2.5 - 3.49	Satisfied
> 3.50	Very Satisfied
2.50	Threshold

The mean average Satisfaction of all the 33 liveability elements within the 5 components under the Housing Unit (HU) across all the estates is **2.88** while the individual housing estates have mean averages ofMIWM(2.73),OAQM(2.88), BLM(2.86), BEM(2.76), and SLKG(3.13).The remaining are FLKG(3.14),SLIB(2.76),and SLBB(2.68).

Housing Estate (HE)

The Housing Estate (HE) comprised of two basic components as indicated below with 16 liveability elements identified: - (i) *Public facilities in the Housing Estate*—Green Area for Relaxation; Play area for Children; Internal Road Network; Car parking facilities; Pedestrian Walkway; Police Post; Street Lighting; Medical Facilities in the Estate; Shopping centres/Corner shops; Educational facilities in the Estate. (ii) *Security, Management, Land use and Relationship*—Land Use Mix; Housing Type Mix (Types of House Units); Waste Management; Maintenance of the Estate; Security Management; Good Neighbourliness.

Table 2: Resident Perceived Satisfaction of the Housing Estate (HE)

S/no	LIVEABILITY VARIABLES	MIWM	OAQM	BLM	BEM	SLKG	FLKG	SLIB	SLBB	TOTAL
		WtM	WtM	WtM	WtM	WtM	WtM	WtM	WtM	WtM
1	Green Area for Relaxation	1.88	2.47	2.21	2.07	2.40	2.87	2.00	2.24	**2.27**
2	Play Area for Children	2.05	2.61	2.35	2.26	3.21	3.14	2.15	2.53	**2.54**
3	Internal Road Network	1.99	2.58	2.60	2.60	3.06	3.19	1.93	1.96	**2.49**
4	Car Parking Facilities	2.11	2.60	2.43	2.49	2.70	3.14	1.93	2.40	**2.48**
5	Pedestrian Walkway	2.22	2.57	2.42	2.45	3.12	3.15	2.15	2.31	**2.55**
6	Police Post	2.34	2.23	2.48	2.27	3.10	3.08	2.39	2.22	**2.51**
7	Street Lighting	2.02	2.75	2.41	2.30	3.04	2.99	1.03	1.22	**2.22**
8	Medical Facilities	2.87	2.71	2.59	2.27	3.06	3.03	1.15	1.22	**2.36**
9	Shopping Centres/Corner Shops	2.16	2.79	2.59	2.74	3.10	3.07	1.00	1.24	**2.34**
10	Educational Facilities	2.55	2.66	2.68	2.76	3.07	3.09	2.68	1.49	**2.62**
11	Land Use Mix	2.45	2.64	2.71	2.56	2.93	2.88	2.15	2.44	**2.60**
12	Housing Type Mix	2.60	2.73	2.83	2.63	3.23	3.24	3.00	1.24	**2.69**
13	Waste Management	1.88	2.70	2.71	2.50	3.74	2.98	1.86	1.00	**2.42**
14	Maintenance	1.93	2.79	2.58	2.30	3.01	2.75	1.44	1.49	**2.29**
15	Security Management	2.12	2.78	2.65	2.26	3.37	2.95	2.22	2.02	**2.55**
16	Good Neighbourliness	3.05	3.21	2.99	3.03	3.10	3.16	3.00	2.49	**3.00**
	TOTAL	36.22	42.82	41.23	39.49	49.24	48.71	32.08	29.51	39.91
	MEAN	**2.26**	**2.68**	**2.58**	**2.47**	**3.08**	**3.04**	**2.01**	**1.84**	**2.49**

The average Satisfaction of all the 16 liveability elements within the 2 components under the Housing Estate (HE) across all the estates indicates a value of **2.49** as shown in Table 2. The various estates, however, show low averages of MIWM(2.26), OAQM(2.68),BLM(2.58), BEM(2.47), SLKG(3.08), FLKG(3.04),

SLIB(2.01) and SLBB(1.84).The mean averages rating for liveability elements within the component of Public Facilities in the housing estate reveal Green area for relaxation(2.27), Internal road network(2.49), Car parking facilities2.48), Street lighting(2.22) Medical facilities(2.36) and Shopping centres/Corner shops(2.34); while second component(Security, maintenance, Land use & Relationship) recorded lower values for Waste management(2.42) and Maintenance(2.29).

Housing Estate Neighbourhood (HEN)

The Housing Estate Neighbourhood (HEN) was made of three basic components with 25 liveability elements identified as indicated below: - (i) *Distances of facilities in the neighbourhood to estate*—Work Place; School; Hospital; Shopping Centre; Local Market; Public Library; Recreational Centre; Fire Station; Police Post. (ii) *Facilities in the neighbourhood*—Local Public Space; Main Water Supply; Main Electricity Supply; Public Transport Access; Major Access Road; Pedestrian Walkway; Petrol Filling Station; Repair Workshop; Public Toilets. (iii) *Noise, security and identity*—Noise in Neighbourhood; Environmental Tidiness; Distance from Highway; Proximity to Noise Generating Activities; Vegetation Buffer with Highway; Public Security Situation; Sense of Belonging & Identity.

Table 3: Resident Perceived Satisfaction with Housing Estate Neighbourhood (HEN) Infrastructure

S/no	LIVEABILITY VARIABLES	**MIWM**	**OAQM**	**BLM**	**BEM**	**SLKG**	**FLKG**	**SLIB**	**SLBB**	**TOTAL**
		WtM	**WtM**	**WtM**	**WtM**	**WtM**	**WtM**	**WtM**	**WtM**	**WtM**
1	Work Place	2.64	3.11	2.58	2.70	3.10	3.39	4.00	3.44	**3.12**
2	School	2.88	3.15	2.84	2.76	3.31	3.44	3.85	3.00	**3.15**
3	Hospital	3.03	3.14	2.62	2.38	3.20	3.38	2.59	3.00	**2.92**
4	Shopping Centre	2.26	3.09	2.55	2.65	3.13	3.40	2.37	2.02	**2.68**
5	Local Market	2.17	3.26	2.34	2.53	3.45	3.30	1.68	3.00	**2.72**
6	Public Library	1.91	2.77	2.15	2.09	2.45	2.24	2.71	1.58	**2.24**
7	Recreation Centre	1.90	2.53	2.23	2.10	2.94	2.85	3.00	3.00	**2.57**
8	Fire Station	1.79	2.48	2.14	2.01	3.01	2.99	3.00	2.53	**2.49**
9	Police Post	2.54	2.24	2.58	2.34	3.00	2.97	2.85	2.20	**2.59**
10	Local Public Space	2.24	2.46	2.55	2.39	3.05	3.12	2.14	3.58	**2.69**
11	Main Water Supply	2.08	1.98	2.25	2.02	3.03	2.99	2.20	3.58	**2.52**
12	Main Electricity Supply	2.57	1.92	2.23	2.29	2.36	3.06	3.00	3.56	**2.62**
13	Public Transport Access	2.35	2.64	2.55	2.56	3.04	3.20	3.63	3.76	**2.97**
14	Major Access Road	2.41	2.88	2.96	2.79	3.10	3.11	3.63	3.24	**3.02**
15	Pedestrian Walkway	2.31	2.61	2.41	2.52	3.07	2.98	2.41	3.00	**2.66**
16	Petrol Filling Station	2.76	2.55	2.42	2.54	3.05	2.85	2.98	3.24	**2.80**
17	Repair Workshop	2.30	2.64	2.31	2.51	2.97	2.77	3.61	2.71	**2.73**
18	Public Toilet	1.78	2.14	1.95	1.96	2.56	2.15	2.27	2.78	**2.20**
19	Neighbourhood Noise	2.81	2.59	2.50	2.54	2.97	2.87	2.59	2.76	**2.70**
20	Environmental Tidiness	2.51	2.82	2.60	2.41	3.11	2.99	2.22	2.98	**2.71**
21	Distance from Highway	2.75	2.91	2.81	2.92	2.99	3.02	3.20	3.02	**2.95**
22	Proximity to Noise Generating Activities	2.72	2.52	2.67	2.64	3.04	2.94	2.17	2.73	**2.68**
23	Vegetative Buffer from Highway	2.54	2.62	2.58	2.54	2.65	2.95	1.75	3.20	**2.60**
24	Public Security	2.35	2.71	2.72	2.33	3.00	2.90	2.22	3.00	**2.65**
25	Sense of Belonging/Identity	3.00	3.04	2.95	2.97	3.04	3.01	3.00	3.00	**3.00**
	TOTAL	60.60	66.80	62.49	61.49	74.62	74.87	69.07	73.91	67.98
	MEAN	**2.42**	**2.67**	**2.50**	**2.46**	**2.98**	**2.99**	**2.76**	**2.96**	**2.72**

The average satisfaction for all the elements under Housing Estate Neighbourhood is **2.72** as indicated on Table 3; while the mean values for the individual housing estates are MIWM (2.42), OAQM (2.67), BLM (2.50), BEM (2.46), SLKG (2.98), FLKG (2.99), SLIB (2.76), and SLBB

(2.96). Across the housing estates lower average values were recorded for distance of estate to Public Library(2.24) and Fire station(2.49); while Public toilets(2.20) was in Facilities in the neighbourhood component.

DISCUSSION AND CONCLUSION

The characteristics of the respondents indicated a very high level of literacy as 99% of the respondents have secondary & post-secondary education implying that the understanding of the content of questionnaire is quite good. The sizes of the houses in the estates have been greatly altered from the original design as 73% of the residents have done one change or the other to their houses. Changes are done usually to cater for new needs in the family especially in the addition of new spaces and rarely for aesthetics, indicating that the houses did not adequately meet their needs; and so changes had to be undertaken to upgrade the houses so as to make the residential environment more liveable. Also, 95% of the residents have spent at least two years and above in their house which is a key factor in determining how well the occupant may know about the residential environment. The tenure of respondents in the housing estates indicated that majority (70%) of them owned the houses. The type of tenure can influence the liveability assessment of residents of a residential area; for example, house rental is a liveability consideration for tenants; while self-ownership gives the resident a very good stand point on the assessment of a residential environment.

The analysis indicated that the housing units were altered from the original design as 73% of the residents have done one change or the other. Also, the lowest dissatisfaction of 2.49 was expressed on the housing estate spatial level while other spatial levels of housing unit (2.88) and housing estate neighbourhood (2.72) were slightly above the 2.5 threshold. The residents expressed dissatisfaction with various liveability variables at the different spatial levels of the housing estates. Therefore, to ensure that residents enjoy good quality living, greater attention must be paid to these variables in the design of new projects or the upgrading of the existing ones. For example, the design or upgrade of the housing estates requires greater attention on the components of Public facilities and Security, Management, Land use & Relationship in housing estates.

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Assessment of Climate Responsiveness of Public Office Buildings Designs in Selected Tertiary Institutions in Niger State towards Energy Efficient Buildings in Nigeria

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Abstract

The building sector had been strongly linked with the global dreaded climate change menace owing to huge energy demand of the sector. Buildings consumed about 40% of the world energy supply and responsible for significant percentages of CO_2 emissions. This scenario has made buildings object of research globally and energy efficiency a major priority. However, climate responsive design has been long identified as effective and economical means of reducing building energy consumption. Thus, most developed nations have explored this medium unlike developing nations including Nigeria. Moreover, offices being high energy consuming buildings, hence reducing their energy use has been a target globally. This study assessed adoption of bio-climatic design strategies office buildings design in tertiary institutions in hot and humid climate of Nigeria. Case study approach was adopted and data were collected via observation checklist from three administrative offices, each from university, polytechnic and college of education in Niger state, Nigeria and results compared with Building Energy Efficiency Guidelines for Nigeria released in 2016. The findings revealed that, critical strategies that impact significantly on energy reduction like orientation, passive measures and Air-tightness of envelope were poorly observed. Therefore, it is recommended that implications of architects' designs on energy demand of buildings should be a major concern. Also, there should be a paradigm shift from the conventional design process to integrated design process (IDP) that encouraged collaborative efforts of other professionals from the beginning of the design process to ensuring planning, design and construction of energy efficient building.

Keywords: *Office buildings, Bio-climatic design, Energy demand, Energy efficiency, Tertiary Institutions.*

INTRODUCTION

The increasing energy demand of buildings and the eventual negative environment impacts has been a major source of worry globally. The building sector having strongly linked with the global warming and the dreaded climate change menace; this is not unconnected to the huge energy demand of the sector. Buildings consumed about 40% of the world energy supply and responsible for significant percentages of CO_2 emissions, this scenario made buildings objects of research globally (Pout, *et al.,* 2002; Huovila, *et.al*. 2007; Asimakopoulus, *et. al*., 2012). Although, there have been several efforts globally towards energy reduction of this sector. These include several peer-assessment reviews such as the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Barker *et. al.,* 2007); the Energy Technology Perspectives (IEA 2008); the Global Energy Assessment (Ürge-Vorsatz *et. al.,* 2011). Likewise, the establishment of World Green Building Council (WGBC) in the year 2002 and establishment of green building rating tools by most developed nations as well as energy codes and standards for various buildings categories. However, Architectural design decisions at the early design stage had been found to impact significantly on the eventual energy demand of building products (Wouters and Loncour (2005); Zhao and Magoules (2012). In this light, architects as a major player in the built environment need to be conscious of the energy demand of their design decisions at early stage. Moreover, bio-climatic design principles/strategies have been long established as an easy and economical means

of ensuring significant energy reduction globally, most especially in tropical climate like Nigeria. Based on this premise, this study investigated the level of adoption/ adherence to these techniques in the design and construction of administrative office buildings in Federal Tertiary Institutions in hot and humid climate of Niger state, Nigeria. Administrative buildings were typical office buildings similar in design, construction and operations to other office buildings outside academic environment. Moreover, office buildings globally have acclaimed to be one of the highest energy consuming human shelters (Ravetz, 2008).

LITERATURE REVIEW

Global Energy Consumption in Buildings

Buildings and its related activities has been strongly responsible for consumption of about half of the global energy supply (Huovila, *et al.* (2007). Despite this, there has been a continuous increase in the global energy use in the recent decades, 3.15% was observed as an average annual energy growth between 2005 and 2011. Meanwhile, in 2011 the global energy consumption rate was 8.92Gtoe/year (International Energy Agency, 2014). This number was predicted to increase to 14 Gtoe/year by 2020. This trend is expected to continue especially in nations with emerging economies like Africa, South America, South-east Asia and Middle East (IEA, 2008). This is so because energy being an indispensable factor that goes a long way to determine the socio-economic growth and life quality all over the entire world (Kousksou *et. al*, 2014; ASHRAE, 1990). Meanwhile, in Europe buildings sector was estimated to be consuming about 40-45% of total energy demand (UNEP, 2007)**.** Specifically in United States of America (USA) building sector consumes about 40% of energy used and responsible for nearly 40% of greenhouse gas emissions. While in China, above 25% of entire energy use is consumed by the building sector, projection has shown that the figure will increase to 35% by year 2020. Furthermore, in United Kingdom, the building industry consumed between 40-50% of all the energy use and greenhouse gases emission, about 27% of the emission from domestic dwellings while public and commercial buildings were responsible for about 22% (Pout *et. al,* 2002; Perez-Lombard *et. al*, 2008; Bouchlaghem, 2012). Equally, in India building sector accounted for 35% of the of the total energy supply in the country (Manu *et. al.,* 2016). Energy scenario in Nigeria was not far from the global reports, building sector equally consumed about 40% of electricity supply (Akinbami, 2010). However, with the gross inadequacy of power supply only about 40% of the population have access to electricity and were majorly urban dwellers (UNDP, 2011).

Review of Building Energy Efficiency Guidelines for Nigeria (BEEGN)

In response to the global call for energy reduction in built environment and to bridge the gap in the National building codes, Nigeria Energy Support Programme (NESP) and the housing unit of Federal Ministry of Power, Works and Housing (FMPWH) in 2016 rolled out a policy document towards ensuring planning, designing and construction of energy efficient buildings. The document was a swift response to the questions of what the state of energy consumption in Nigeria is; what energy efficiency goal can be set for Nigeria and finally how energy efficiency can be effectively implemented in Nigeria. This document named "Building Energy Efficiency Guidelines for Nigeria" (BEEGN) was introduced to guide relevant stakeholders in the building industry in Nigeria. However, it was noteworthy that the guidelines concentrated on the new

buildings rather than improving existing ones. Notwithstanding, some of the solutions could also assist towards improving the performances of the existing buildings.

The document acknowledged the fact that building sector accounted for the largest proportion of electricity consumption in Nigeria (BEEGN, 2016). It looked at legislations and policies including Renewable and Energy efficiency policies of 2015 as well as energy mix, sources and carbon footprint from energy production. Also, noteworthy was the difficulties involved in estimating energy use in Nigeria, this was borne out of the fact that large percentage of energy is generated on-site via petrol and diesel generators. Besides, the guidelines stressed the need for integrated design process (IDP) as opposed to the conventional design process. IDP encouraged active participation and collaborative effort of other professionals from the beginning of the design process to ensure planning, design and construction of energy efficient building. Most importantly, the document presented set of guidelines based on bioclimatic design approach to ensuring energy efficient building design that is premised on building physic concept of heat flow in and out of buildings in tropical hot-dry and hot-humid climate of Nigeria.

Bio-climatic strategies for hot and humid climate in Nigeria

Bio-climatic design concept is based on the vivid understanding of the climate parameters of a particular location. This concept is a strong tool that can be harness by architects to achieve energy efficient buildings. Energy efficient buildings ensure physical comfort for occupants with minimum use of resources, most especially energy consumption. This concept in tropical climate like Nigeria required in-depth knowledge of heat flows in and out of buildings. This phenomenon is premised on adaptive thermal comfort theory which explained the impact of outdoor weather conditions on the thermal comfort of indoor environment. This concept has been acclaimed to be the starting point in the sequence of planning, design and construction of energy efficient buildings as illustrated in Figure 1.

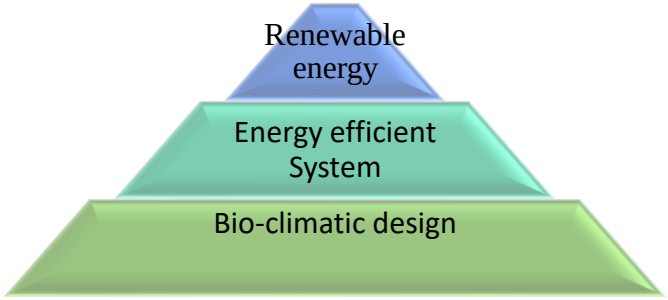

Figure 1: Heirachy of energy efficient buildng design
Source: Arup (2014)

The climate parameters mostly considered in bio-climatic design include air temperature, solar radiation, sun angle, relative humidity, wind speed and direction and precipitation. The orientation of the building in relation to geographical north is the main factor that determined the energy balance of building in hot and humid climate, as it affects the air movement and solar heat gain. The building in this climate is expected to be oriented with the longest side in North/south direction where most windows are expected to be located. Also the building geometry is equally significant to energy use, reducing building outer skin in relation to volume proportionally reduces heat gain,

and therefore buildings are expected to be compact with the use of courtyard to aid daylight and ventilation. Furthermore, exterior shading is equally important, overhang and horizontal shading is advised North/South direction while combination of vertical and horizontal shading is encouraged on the East/West direction, this approach should be complemented by planting of trees. The glazing Solar Heat Gain Coefficient is expected to be low while the visual transmittance should be high not less than 60%. Also the envelope materials should have light colours to reflect heat while roof solar reflective index (SRI) higher than 78 is recommended. The opaque wall is also recommended to have a low thermal transmittance value (U-value) to act as good insulator. Notwithstanding, the buildings should further ensure that the envelope is airtight with low thermal mass and evaporative cooling could be incorporated to further reduce heat gain.

METHODOLGY

This study adopted a case study approach. However, having prior understanding of the element of the population that will give the desired results informed the purposive sampling method adopted (Ranjit,1999) to select the main administrative buildings being typical office buildings in Federal Tertiary Institutions that cut across University, Polytechnic and College of Education in Niger state, Nigeria. The photographic documentations of case study buildings B1, B2 and B3 for case study building one, two, and three are presented in Plate I, II and III respectively.

Plate I: Adminstrative building, Federal University of Technology, Minna. (B1)

Plate II: Administrative building, Federal Polytechnic, Bida (B2)

Plate III: Adminstrative building, Federal College of Education, Kontagora (B3)

Source Author's Fieldwork, 2018

RESULTS/DISCUSSION OF FINDINGS

The buildings were assessed based on four variables that may minimise heat penetration and reduce energy demand of building as recommended by BEEGN (2016). The variables were building orientation, building form and geometry, building envelope and passive strategies. The outcome of the field exercise is presented in Table 1. The building orientation in relation to geographical north is the most important consideration in bio-climatic design towards energy reduction of built environment. All the buildings were oriented with their main axis in north/east

(N/E) direction which was in contrary to the recommended position, despite adequate spaces to ensure proper orientation. The buildings had their longest sides where most windows were located on the east/west (E/W) axis in the direction of direct solar penetration. The implication of this is that more energy will be required for indoor comfort. Moreover, the results of building form and geometry revealed that all the buildings complied partially. The buildings forms were open and permeable for air movement which is in accordance with the recommendation of BEEGN. Buildings surface to volume (S/V) ratio determined the compactness of building design, the lower the (S/V), the lower the cooling load demand. The results of (S/V) were 0.19, 0.22, and 0.26 for B1, B2 and B3 respectively. This means that B1 has the lowest figure, which implied that B1 had lesser outer skin exposed to solar penetration in relation to the volume. Consequently, lesser cooling load will be incurred. Also the buildings layouts were narrow, with courtyard concept that incorporated shaded balcony that aids daylight, ventilation and reduce heat penetration. This means that the buildings might use less energy for lighting and ventilation. Notwithstanding, compactness of the building form could be improved upon, by reducing the S/V ratio for further heat gain reduction.

Table 1: Variables examined and outcome of the field exercise.

Variables Examined	B1	B2	B3
1.Building orientation	N/E (main axis)	N/E (main axis)	N/E (main axis)
2.Building form & geometry	S/V=0.19, courtyard concept, shaded balcony	S/V=0.22, courtyard concept, shaded balcony.	S/V=0.26, courtyard concept, shaded balcony.
3.Building envelope			
-Wall	225mm Sandcrete block, U-value=1.6,W/m^{2}K, white colour	225mm Sandcrete block, U-value=1.6,W/m^{2}K, white colour	225mm Sandcrete block, U-value=1.6,W/m^{2}K, white colour
-Glazing	Single clear glass (V.T= 88%, g- value = 0.82)	Single clear glass (V.T= 88%, g- value = 0.82)	Reflective glass (V.T=11%, g-value=0.23)
-Roof	Light green aluminium (SRI=50)	Silver colour aluminium (SRI=79)	Red colour aluminium (SRI= 47)
-Shading	Horizontal/vertical (700mm) in S/W,N/E,S/E.	Recess wall (450mm) in S/E and N/W	No shading
Air-tightness	Air gap in windows & doors	Air gap in windows & doors	Air gap in windows & doors
4.Passive strategies			
-Double skin system	Not adopted	Not adopted	Not adopted
-Evaporative cooling	Not adopted	Not adopted	Not adopted

Source: Author's Fieldwork, 2018.

Note: S/V=surface to volume ratio, U-value= thermal transmittance value, V.T=visual transmittance, g-value= solar factor, SRI=solar reflective index.

Furthermore, the outcome of the envelopes materials shows that all buildings shared commonalities in terms of opaque walling materials, 225x225x450mm plastered on both surfaces with U-value of 1.6 W/m^{2}K which was finished with white colour except B3 with dark orange. Also all the buildings used longspan aluminium as roof covering, the SRI based on the roof colour are 50, 79 and 47 for B1, B2, and B3 respectively. However, according to Akbari (1992) light

colours and reflective materials can reduce heat gain by 30% on hottest hours of the day. This means that B1 and B2 minimised heat gain better than B3 in terms of wall surface colour while B2 had better heat reflective capacity. This is so because the higher the SRI, the better the reflective performance. The glazing revealed that B1 and B2 had 6mm single clear glass with V.T and g-value of 88% and 0.82 respectively. While B3 used 6mm reflective glass with poor V.T of 11% but with a better g-value of 0.23. However, higher V.T and low g-value was recommended for hot and humid climate. Therefore, this means that B1 and B2 enjoyed better illumination above 60% recommended while B3 with lowest g-value gives better performance by reducing heat gain through the entire glazing area. External shading against solar radiation analysis revealed that all buildings except B3 had one form of shading technique or the other. B1 had combination of vertical and horizontal in S/W, N/E and S/E with average depth of 700mm. B2 employed recess wall system to shade the windows with average depth of 450mm in S/E and N/W axis while B3 had no shading device at all. Only B1 complied with the recommendation by BEEGN with right shading type in the recommended axis coupled with few trees. This means that B2 and B3 may not perform optimally to screen solar radiation for effective thermal control. Although, B2 will give a better performance with the recess wall and few trees unlike B3 without any shading device and trees. All the buildings were not properly sealed, air gaps were visible on the window and door areas which is an avenue for energy leakage thereby amounting to wastefulness. Finally, all buildings had single wall construction; there was no case of double skin system and evaporative cooling as mitigation to the challenge of heat penetration.

CONCLUSION AND RECOMMENDATION

The study had examined the adoption of Bio-climatic design variables in the design of administrative office buildings in tertiary institutions in Niger state, Nigeria. The study revealed that bio-climatic design was partially adopted. Obviously, orientation of building being the major determinant of energy balance of buildings was not given critical consideration as well as passive strategies. Also thermo-physical properties of envelope components during specification of materials and air-tightness of building joints during construction should be paramount by professionals concerned. The U-value of the opaque walling materials being the major component of the envelope can be further lowered for belter thermal performance by application of appropriate insulation type and thickness on the external surface. In this light, the study recommended that all professionals involved in planning, design and construction of buildings should be energy conscious by embracing bio-climatic design principles towards a sustainable built environment in Niger state and Nigeria at large. To achieve sustainable built environment, there is need for paradigm shift from the conventional design process to integrated design process (IDP) that ensures active participation and contributions of other professionals right from initial design stage to achieve a building product that is energy efficient.

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The Characteristics of Kaduna Metropolitan Solid Waste Management Practices

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Abstract:
Nigeria is one of world's countries with the largest rates of urbanisation and persistent challenges in solid waste management. Rapid rate of urbanization is associated with problems in urban services delivery, waste management inclusive. This paper examines the characteristics of solid waste management practices in Kaduna metropolis with the view to identifying challenges towards evolving recommendations for improvement. Secondary data were acquired from relevant published and unpublished dissertations, reports from government ministries and agencies, Nigeria Infrastructural Advisory Facility, NIAF and internet sourced materials such as e-books which provided the focus and theoretical basis for the study. Primary data were collected through field survey, observations and face to face interview with officials of KEPA and Private Solid Waste Management Services Provider involved in solid waste management in Kaduna metropolis. The study revealed that the absence of proper planning in conjunction with dearth and verifiable data hinders multi-operational entities in the management of waste, low levels of transparency and accountability, inadequate and restricted service coverage of communities, and inadequate human and technical reports with facts and figures / resources. These findings provided recommendations that would enhance a sustainable framework for improvement of the current management practices. The paper recommended creation of enabling framework for waste management, creating a transparency and accountability unit to check malpractices, initiate modalities for wider coverage and improvement of technical know-how.

Keywords*: Solid Waste, Sustainable framework, Integrated, Management, Urbanisation.*

INTRODUCTION

Kaduna metropolitan area has experienced significant spatial and population growth for the past two (2) decades (Max Lock, *et.al*, 2010). It is the third most populated state in Nigeria with a population of about 6 million persons at growth rate of 2.47 % with her four (4) Local Government Areas that make up the metropolis with a population of 1,558, 563 (Max Lock, *et.al*, 2010). This agglomeration in turn, is associated with problems of urban services delivery including solid waste management services. By extension, the increasing urbanization rate means increase in the amount of waste generation, without the institutional and operational system for services delivery meeting up the need. This further translates into heaps of refuses and indiscriminate dumping of waste in the city which illustrates a symptom of perceived ineffective operational and institutionalized mechanism. Some studies in solid waste management have been extensively done within the general context of problems in practice, operations, public participation, and providing solutions on solving observed problems towards improvement in Zaria, Kaduna, Owerri, and Tanzania cities (Agunwaba, 1998, Julianne, 2008, Ukoje, 2011, Chidi, Romanus and Thelca, 2010, Abu, 2017, and Ajayi, 2019). Rich as these knowledge base are, there remains insight on solid waste management governance towards making sustainable recommendation for solid waste management practice synthesized from the characteristics of the institutional framework towards

improvement. Therefore, the urgent need to evolve recommendations that are capable of offering a sustainable solution that will address the persistent problems of solid waste management. This paper hereby examined the characteristics of solid waste management practice in Kaduna metropolis towards evolving a sustainable recommendations for improvement. The aim of this paper was achieved through the following sets of objectives: review of the concept of solid waste management, examining the characteristics of solid waste management practice in Kaduna Metropolis and providing recommendations and solutions towards improvement of solid waste management practice in Kaduna Metropolis.

The Study Area

Kaduna Metropolitan area lies along Latitudes 10°25'15"N and 10°36'08"N and Longitudes 7°23'31"E and 7°29'33"E (Figure 1.0).). Kaduna Metropolitan area is the capital of Kaduna state, and consists of two (2) Local Government Areas-Kaduna North, Kaduna South, and parts of Chikun and Igabi LGA's with 24 urban districts (Figure 1.1). The metropolis covers 260 km^2 area at extents of 13.7km from the Eastern to Western limits and 20Km north and south of the metropolis (Ajibuah, 2008 and Ayuba, Tanko, and Bulus, (2016)). It is a cosmopolitan town with a huge diversity of religious and ethnic groups. By the 2006 Population census, the metropolis has a population of 1,139,578, at a growth rate of 2.53% and projected 2,057,078 people in 2015 (Federal Republic of Nigeria, 2009). Solid waste management is generally contracted to a private waste management Services Provider and supervised by the Ministry of Environment and Natural Resources, MENR and Kaduna State Environmental Protection Authority, KEPA (Max Lock *et.al*, 2010).

Backdrop to Solid Waste Management Governance in Kaduna State

Table presents the several associated collaboration challenges observed on waste management in the study. The antecedent of Solid waste management in Kaduna can be traced during the reign of the Governor of the Headquarter of the Northern Protectorate, that was handled by the Native Authority (1940-1967).

Table 1.0: Solid Waste Management SWM administrative framework between (1940-to date) in Kaduna

CITY	PERIOD	MANAGEMENT
Kaduna	1940-1964	Kaduna Native Authority.
"	1967-1971	Kaduna Local Government
"	1972-1985	Kaduna Capital Urban Dev. Board (later Kaduna State Urban Planning and Dev. Board)
"	1985-1991	Kaduna Local Government and Private Contractors.
"	1991-1994	Kaduna State Urban Planning and Env. Protection Authority (KASUPEPA)
"	1994-date	Ministry of Environment/ Kaduna State Environmental Protection Agency (KEPA) and PSP's

Source: Kaduna State Ministry of Environment & Natural Resources and KEPA, 2017

The Kaduna Local Government Council during the creation of LGC in the country (1967-1971), Kaduna Capital Urban Dev. Board (later Kaduna State Urban Planning and Dev. Board) (1972-1985), Kaduna Local Government and Private Contractors (1972-1985), Kaduna State Urban Planning and Environmental Protection Authority (KASUPEPA) (1991-1994) when an environmental department was established in the planning agency due to the persistent problems on sanitation, solid and liquid waste matters becoming worrisome in the state. The creation of Federal Environmental Protection Authority (FEPA) in 1992 mandated all states to establish their state agencies, which necessitated the establishing of KEPA in 1994 who took over the

responsibility of waste management and technically funded by the United Nations Development Programme in 1998. However with the creation of the Federal Ministry of Environment and Natural Resources in 1999, the governance of the solid waste management became a function of both the MENR, KEPA and a contracted PSPs (MENR and KEPA 2017) r.

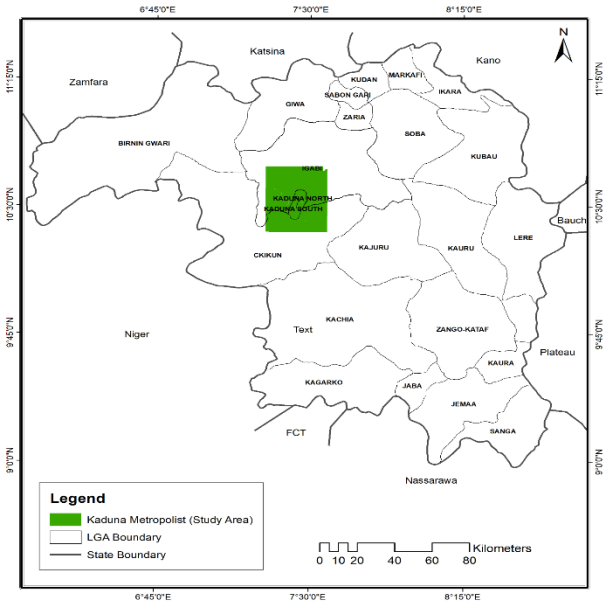
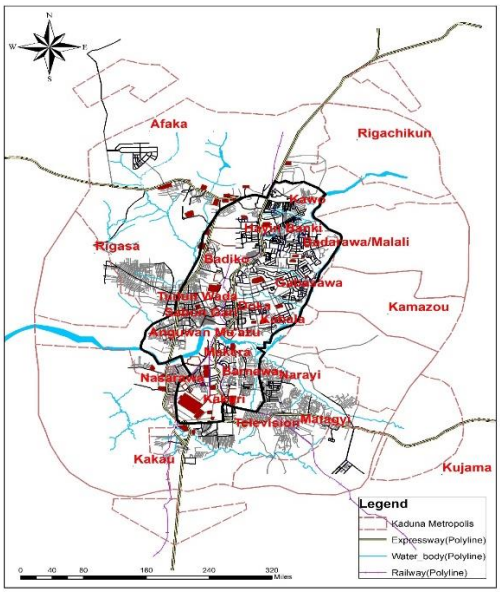


Figure 1.0 Kaduna Metropolis in Kaduna State
Source: KADGIS, (2017).


Afaka
Rigachikun
Rigasa
Sabon Gayan Dogaki
Sabon Gayan Dogaki
Sabon Gayan Dogaki

would also involve the storage, collection, transportation and disposal of waste generated in the homes, commercial premises and institutions.

Solid Waste Management Process and systems

Tchobanoglous, Theisen, and Vigil (1993), Snell and Ali (1999) and UNEP (2005) stated that the process of municipal solid waste management includes: First, Waste Generation and Storage: MSW is largely generated from household and other activities such as shops, hotels, restaurants, institutions, markets, community halls, hospitals, slaughter houses and construction sites. Waste generation per capita, per household, per city varies in quantity and types depending on the predominant land use per location (Figure 1.0). For storage, most households usually use small containers/ bins/ receptacles, while shops, hotels, institutions and industries require large containers. Manual handling is sufficient for smaller containers while motorized and mechanical handling for larger ones. There are two types of waste containers: Stationary containers; which contents are usually transferred with collection vehicles to storage sites. Hauled containers; contents are transferred to processing plant, transferred stations or disposal sites before emptying. What is important here, as far as municipalities are concerned is the identification of sources of waste.

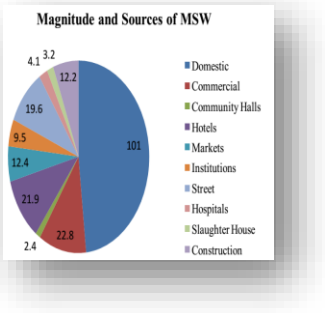


Figure 1.1 Municipal waste generation, sources at Kerala, Source: Adams Smith (NIAF), 2016.

Figure 1.2: Key Components of SWMIndia (0.242 kg/capita/day

Secondly, is waste collection; this includes gathering of wastes and hauling them to the location where the collection vehicle is emptied, which may be a transfer station, a processing plant, or a disposal site. These could be curbsides (road sides), Backyards (collectors pick waste from homes), Torte Barrel, Set-out, etc. the types of vehicles used for collection includes Compacting trucks (rare-loading, side loading, front loading) and non-compacting trucks (Open tipping, covered side loading tipping, Roll-Roll-Off (RORO), and skip vehicles trucks). Thirdly, transportation: this is a means of conveying of waste materials collected from collection points, transfer stations to the grave that is, the disposal/ treatment / landfill sites. Normally, large vehicles such as trucks that have a capacity of 20 to 30 cubic meters are used for a long-distance transport of waste for disposal or treatment. Lastly, is Disposal and treatment: this stage involves providing a site where waste is finally disposed either by open dumping, Land filling/ tipping, incineration, composting and treatment (pyrolisation, shredding and compaction) just to mention a few. The United Nations Environmental Program (2005) further states that, the management of solid waste comprise of prevention and disposal. Waste prevention involves dropping the overall quantities of waste to reduce harm to the environment, While, waste disposal collects, segregates, handles, transports

and treats the waste at the final disposal point (UNEP, 2005, and Smith, 2016). The priority of waste prevention and waste disposal is to attempt maximum extraction of components and minimum overall waste generated which can be achieved through 3Rs – Reduce, Reuse and Recycle (White, Frank, and Hindle, 1999; UNEP, 2005). For effective management of waste and to help reduce adverse impacts on the environment and human health; a number of processes are involved like monitoring, collection, transport, processing, recycling and disposal.

Integrated Solid Waste Management, ISWM

Integrated Solid Waste Management, ISWM is a strategic approach to sustainable management of solid wastes across the management chain, that is generation, segregation, transfer, sorting, treatment, recovery and disposal with a view to maximize resource use (UNEP, 2005). Therefore, the prediction of waste generation and characterization becomes crucial in developing a robust SWM framework (Kolekar, Hanzra and Chakrabarty, 2015). The foresaid usually provides the guidelines towards achieving a Sustainable Solid waste management process for its potency in the use of various collection, transport and treatment options (White, Frank, and Hindle, 1999). Smith (2016) adds the following as the key components of SWM;

1. Governance: Political and Administrative commitment to waste management;
2. Planning: strategic blue prints and plans for execution;
3. Infrastructure systems/ Service: Vehicles (hardware) and Staffing;
4. Financial resources: Funds availability and recovery mechanism; Human Resources: Recruitment/ training and retraining periodically; Monitoring and Evaluation: Regulating the actors/ service providers; all of these components ensures feasible implementation of Solid waste Management (SWM) (Figure 1.1).

Adama (2007) further attest that challenges associated with municipal solid Waste Management are not new in our present society, but its manifestation seems to be changing and therefore would require new approaches to solving and handling these problems. Therefore, the adoption of the views of the foresaid authors wouldn't be a bad idea in achieving a SWM for any city.

METHODOLOGY

This study is purely a qualitative research that employed the conduct of interviews focal group discussion with one (1) principal officer each for MENR and KEPA and three (3) field staff of KEPA in the solid waste management unit (i.e. the waste monitoring/ inspection and surveillance team) and the Private Service Providers respectively, this helped to obtain information on the operations and general practices, type of waste generated, frequency of evacuation, availability and accessibility to waste collection sites. Field surveys, inventories, and observations were carried out in other to establish the characteristics of the solid waste collection, disposal sites and general practices. UNEP ISWM guidelines was adopted and used to analyse the characteristics of the study area as well as the potentials and weaknesses of the institutional framework responsible for solid waste management. Graphical summaries of descriptive statistics in form of tables, percentages and pictures were used to present the facts on situational analysis of the study area on waste management practices.

RESULTS AND DISCUSSIONS

The Characteristics of Solid Waste Management in Kaduna Metropolis

Absence of proper planning: An interview with the Director Monitoring and Enforcement, KEPA revealed that Kaduna State neither has an environmental policy nor adopts the Federal Ministry of Environments' policy, strategies and plan that spells out what to be done, who does it, how and where it should be done on matters relating to solid waste management. He further revealed the existence of regulation no. 1 on solid waste management of KEPA, which is grossly inadequate in terms of providing the basic blue prints for strategic and sustainable waste management. He further attests to the popular practice of 'fire brigade' approach (interventions) on the collection of heaps of waste that dumped and accumulated at various collection points in the metropolis. The Director, regretted the absence of reliable records on the amount of waste generation per capita in the metropolis except for the one estimated by Kalausa (1999) (Table 2.0). This is grossly unreliable and none representative of the general population of Kaduna Metropolis, being that a sample size of only one hundred households were drawn from the entire metropolis, which would mean an unclear estimations on the total amount of waste generated per capita per day. It can be inferred from the above, that the law establishing KEPA gives her the legislative mandate to handle all matters relating to environmental, and the regulation no. 1 on solid waste management only provides trivialities on waste management only specifies that "every property occupier is responsible for their solid waste from the point of generation, by providing sanitary waste bins" only. This can be considered weak only providing trivialities on waste management and an incomplete process of management along the management chain. Secondly, a reliable local data for waste generation is close to absent, because the one provided by Kalausa (2009) is unverifiable in the waste management process of Kaduna. The quantification of waste generation should be a strong inertia for proper planning and management and its absence leaves the system to chance.

Table 2.0: Household Solid waste generation per LGA in Kaduna Metropolis

Parameter	Kaduna North	Kaduna South	Chikun	Igabi	Total
Non-biodegradable	887 kg	864 kg	1,835 kg	1,775kg	5,361 kg
Bio-degradable	1,537 kg	1, 438 kg	2,728 kg	2,485kg	8,188 kg
Kg/Per capita/day	2,224 kg	2,293 kg	4, 563 kg	4, 260 kg	13, 540 kg

Source: Kalausa, 2009. (Adopted a sample size of 100 household per LGA)

Multi operational entities in the management of waste: Another interview with the Director of Environment of the MENR revealed that, the Ministry of Environment and KEPA have been experiencing conflicts on who handles the waste management job between the Ministry and KEPA. Though he stated that the law establishing KEPA gives her the legislative mandate to handle all matters relating to the environment, and the regulation no. 1 on solid waste management mandates KEPA to manage solid waste in the state, but KEPA is an agency under the Ministry. The Director of Monitoring and Enforcement revealed that Before, the present administration in 2015 on the governance of Kaduna State, the Ministry of Environment & Natural resources houses KEPA as an agency under the Department of Environment, this allows the Ministry of Environment to be responsible for the activities of waste management (policy makers), while KEPA monitors and evaluate the activities of solid waste at skeletal level. He further states that with the public-sector reform, KEPA has a unit of Solid waste management under the department

of Monitoring and Enforcement, and as at the time of this interview KEPA is in charge of solid waste management under the supervision of the Ministry and the Government house. It can be inferred that from the foresaid that perhaps, the conflict between the two agencies is attributed to the non-existence of State Environmental Policy or and the creation of two government bodies with similar responsibilities. This multi-jurisdictional responsibility has brought about undefined and overlapping roles which in turn leading to fragmentation and non-coordination of activities towards achieving effectiveness and efficiency in the entire process.

Low levels of transparency and accountability and high levels of malpractices: A focal group discussion with three field officials of KEPA lamented that despite the low rate of performance of a PSPs in the evacuation of solid wastes at the collection points the remunerations of the PSPs are paid without any form of deduction or sanctioning, and even when they report non- performance it remains inconsequential. It can be inferred from the foresaid and the evidence in plate 1.0 and 1.1 heaps of uncollected waste scattered within the metropolis and a filled haulage without collection that perhaps, the interest of the waste contractor is only being protected due to some corrupt practices.

Plate 1. Uncollected solid wastes scattered along Kachia road. Plate 1.1 spilled uncollected waste at a collection point
Field survey, 2017

Inadequate Services coverage to communities:

A discussion with the Private Service Provider contracted by government revealed that their area of coverage on the 24 districts of operation is only restricted to only the major routes with the inner cores of such communities deprived and only four Local Governments of the metropolis enjoys their services. They further stated that the roads leading into the core areas of the community are in poor conditions and inaccessible, and their trucks and compactors cannot easily pass through. The physical observation made during the field survey reveals the high density areas with problems of poor road networks and conditions and accessibility are the ones in dire need of these services, they walk long distances to drop their waste along the major routes. While the low density areas seemingly engage the services of Private registered companies to dispose their waste. It can be deduced from the foresaid, the services of the PSPs is inadequate on the extent of area coverage for households on the major routes and depriving those at the community or urban district core areas. Furthermore, PSPs do not collect waste within the core areas of the communities that are dire need of the service. Most of such areas result to dumping their waste along open drains/ water courses, abandoned or uncompleted buildings and areas of gully erosion. However, the Director

in KEPA revealed that they sometimes these areas enjoy interventions from the State Government occasionally.

Inadequate Technical Resources within the Government Sector. The Director and field staff of KEPA complained of inadequate monitoring vehicles with only (one Hilux van, and few motorcycles) for monitoring and surveillance. He revealed that the PSP contractor of Government possess four (4) operational compactors, one pay loader for lifting of haulage RORO that are used as transfer stations. Plate 2 shows the manual process of emptying a haulage (transfer station) by the waste workers, which exposes them to solid waste bound infectious diseases and drudgery. The PSP also attested that most of the tipping trucks in use are on hire basis. This in turn may encourage restrictions of frequency of trips being a business venture for both the leaser and the leasee; this is likely to initiate low frequency of waste collection and transportation to disposal sites. The Director of KEPA revealed that there are two designated sites serving as landfills in the metropolis, located at Gonin-Gora Kaduna Abuja Express way and Afaka along Birnin-Gwari-Kaduna expressway. A visit to the Gonin-Gora landfill uncovered scavenging activities on waste sorting, and open air burning **(plate 3).** The study observed poor and inappropriate methods used for the collection of waste is inappropriate due to the absence of the suitable technology for collection practices due to largely absence of suitable technology. As a result waste collection staff were seen raising collected waste via a sack media that could encourage drudgery with gross health implications (**Plate 4).** Additionally, the area lacks transfer stations that could aid waste sorting and No any evidence of any form of waste treatment was observed during visit to the dumpsite.

Plate 2 emptying of haulage **Plate 3** open burning landfill with scavengers **Plate 4** waste collectors loading a truck

Recommendations for Improvement of Solid Waste Management in Kaduna

Creating an enabling framework for the waste management

Kaduna State Government as a matter of urgency should ensure the review the existing legislation on waste management in Kaduna and also prepare an Environmental policy document that would clearly express who does what and how in order to remove the bottle necks of overlapping roles on solid waste management between the MENR and KEPA. The Research and Statistics unit of KEPA should collaborate with any of the consultancy firms of any of the tertiary institutions in Kaduna towards a conduct of an extensive and intensive study on quantification or estimations of the amount of waste generation in the metropolis. Without which no meaningful synthesis of a good blue print or MSW management plan along the management chain can be produced.

Creation of accountability and transparency unit to checkmate malpractice

The supervisory role of the regulatory agency that is KEPA can be reinforced by establishing an accountability and transparency unit where the activities of the both the regulator/ service provider is being monitored. Also, all sanction cases from the field inspectors due to non-performance of the Service provider must be enforced, this will in-turn translate into increasing performances of the PSPs.

Improvise modalities for wider coverage into the deprived areas of the metropolis

The rehabilitation of roads at the urban districts within the metropolis becomes inevitable due to the fact that only when roads are constructed and rehabilitated the heavy trucks cannot reach out to the core areas of the communities in dire need of the MSW collection services. In the interim smaller trucks could be provided for easy manoeuvre of the existing bad roads.

Improving of technical know how

The improvement of the technical requirement for monitoring, evacuation of waste, and the activities at the landfill will largely be pivoted by the creation of an enabling blue print for the MWM along the management chain. However, the purchase of adequate vehicles and constant servicing would a long way to increase effectiveness of the process. In addition, adoption and provision of appropriate technologies must be done, to protect the staffers of the service provides from respiratory diseases and drudgery. Government can initiate partnerships and search for grants towards redeeming the technical integrity of the MSW services in Kaduna. The Establishing of a strong collection, recycling, disposal and treatment Scenarios. This requires provision of an adequate and strategic collection points, recycling plants, clean and globally accepted disposal and treatment for all waste types that will go a long way to improve practice.

CONCLUSIONS

This paper has established the characteristics of solid waste management systems of Kaduna Metropolitan area which includes absence of proper planning, Multi operational entities, low transparency and accountability and Inadequate service coverage and inadequate technical know-how. Several recommendations were made that would aid achieving a healthy environment in Kaduna.

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Assessment of Crime Prevention through Environmental Design (CPTED) in Shopping Malls in Nigeria: A Case of Ceddi Plaza Abuja, Nigeria

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Abstract:

Crime Prevention through Environmental Design (CPTED) is a place-based crime strategy. It affirms that, the proper design and efficient use of the built environment can lead to a reduction in the fear and incidence of crime and an improvement in the quality of life. Crime has been a growing social problem in Nigeria, due to rapid urbanization. The challenge for shopping malls is the creation of an environment that is at the same time entertaining and safe. The aim of this study is to assess CPTED principles in shopping malls and how they relate to the perceived safety of users. The study was conducted in Abuja. Data for the study was obtained from case study. The instruments used for the data collection in this study were a structured questionnaire and CPTED Audit. The findings suggest that traditional CPTED principles are being implemented within the design and built form of the study area. The CPTED audit and the personal safety surveys both reported high levels of CPTED features within the environment. Although exploratory, these findings suggest CPTED is identified within the environment in similar ways by a CPTED audit and by citizens in the personal safety survey. CPTED concepts appear to be intact.

Keywords: Crime, Environmental Design, Perception, Shopping Mall

INTRODUCTION

Crime prevention according to the National Crime Prevention Institute (NCPI) is the anticipation, recognition, and appraisal of crime risk and coming up with some actions to remove it (National Crime Prevention Institute, 1986). Crime Prevention through Environmental Design (CPTED) is the proper design and effective use of the built environment which leads to a reduction in the fear and occurrence of crime and an improvement in the quality of life. The goal of CPTED is to lower the chances for crime that may be inherent in the design of structures or neighbourhoods (Crowe, 2000).

The comparative advantages of location, administrative, economic and other functional factors have contributed to the ample increase in shopping activities. Rising on the back of demographics, rapid urbanization, changing shopping culture and an increased growth of middle class, the expansion sweeping through the retail market in Nigeria is getting broad as the market expect about 200,000 sqm of real estate space (Caroline, 2014). Nigerian retail market growth is a direct reflection of the growing complexity of the Nigerian middle class, whose shopping preference has shifted from the traditional shopping in the open market, to a more organised and convenient shopping experience offered by retail malls (Odinaka, 2014). In order to achieve a convenient shopping experience, there is need for the shoppers to feel safe while they carry out their shopping activities.

CPTED opines that the tactical and purposeful manipulation of the neighbourhood design can discourage potential offenders to commit crime (Crowe, 2000; Cozens, 2014; Cozens & Love, 2015). CPTED principles focus on four major strategies that should be present in the built environment to prevent the occurrence of crimes. These are: Surveillance, territorial reinforcement, access control and maintenance (Crowe, 1991).

Crime has been a growing problem in Nigeria due to a more rapid urbanization. The great challenge for shopping malls is to create an environment that is at the same time entertaining and safe (Kajalo & Lindblom, 2016). As a public facility, every shopping mall needs to be safe for human benefit; crime prevention measures must be put into consideration right from the preliminary shopping mall design to completion. However, it is necessary to explore different means that will serve as a means to reduce opportunity for crime in shopping malls, so as to achieve a convenient and comfortable shopping experience

The aim of the study is to assess CPTED principles in shopping malls and how they relate to the perceived safety of users

LITERATURE REVIEW

An Overview of CPTED Concept

CPTED is an acronym for Crime Prevention through Environmental Design. It affirms that 'the proper design and effective use of the built environment can lead to a decrease in the fear and occurrence of crime, and an improvement in quality of life (Crowe, 2008; Cozens, 2000). Aim to proactively prevent crime, as compared to the reactive strategies of most criminal justice systems like police, courts and correctional facilities (Cozens and Hillier, 2012).

"Crime Prevention though Environmental Design" was first establish by C. Ray Jeffrey, a famous criminologist from Florida State University. His first work, "Crime Prevention through Environmental Design," was published in 1971 and offered a special perspective of integrated systems to crime-related study (Robinson, 1996). Jeffrey developed his theory based on experimental psychology represented in modern learning theory on the bases that the physical environment can produce either pleasurable or painful experiences, which in turn have the power to alter the behaviour of potential offenders (Robinson, 1996). Jeffrey went head to develop CPTED model in his 1990 publication, "Criminology: An Interdisciplinary Approach". His 1990 publication discuses integrated systems perspective, which connects two critical principles of CPTED through a biological-psychological approach; the place where the crime occurs, and the individual who commits the crime (Robinson, 1996). This means that behaviour can be influenced by altering the external, physical environment of the place, and/or the internal, psychological environment of the offender.

Crime Prevention through Environmental Design (CPTED) Elements

The principles of CPTED have been discussed by many authors, including but not limited to Poyner (1983), Cozens *et al.* (2005) and Armitage (2013) and adapted across distinct countries to form the attributes of safe places/environments within planning policy and guidance. Poyner (1983) listed the principles as surveillance, movement control, activity support and motivational reinforcement. Cozens *et al.* (2005) extended these principles to include the seven principles of defensible space, access control, territoriality, surveillance, target hardening, image and activity support. Armitage (2013) proposed yet another combination of physical security, surveillance, movement control, management and maintenance and defensible space. Montoya *et al.* (2014) assess impact of the six principles of territoriality, surveillance, access control, target hardening, image/maintenance and activity support on burglary related offences. Finally, Marzbali *et al.* (2016) propose four dimensions - surveillance, access control, territoriality and maintenance, and

eight sub-dimensions – visibility, physical barrier, security system, markers, lighting, landscaping, front house maintenance and back-lane maintenance.

Surveillance

Natural surveillance is a long-established crime prevention measure. Opportunities for residents to observe the street are presided by the design of the street, the location of entrances, and the placement of windows, for example. This natural surveillance is considered as a form of capable guardianship that has the potential to reduce crime since offenders who perceive that they can be seen (even if they are not), become less likely to offend, in the light of the increased potentials for intervention, apprehension, and prosecution. (Cromwell and Olson, 1991).

Physical security

Target hardening is often referred to as physical security and it includes the initial design, or retrofit upgrade of doors, windows, fences and other physical structures to make it difficult for offenders to enter a building or space. Research on security measures as a means of preventing burglary opines that, all other factors being equal, burglars chose to offend against properties that has lower levels of physical security (Cromwell & Olson, 1991).

Limiting access and through movement

Access control refers to the design of buildings and functions to actively restrain people from access to places. This principle has traditionally been referred to as access control, may be due to its routes in more traditional situational crime prevention measures to restrict access into buildings and rooms within buildings. (Cozens *et al.* 2005)

Image/management and maintenance

Cozens *et al.* (2005) use the term 'image', while other authors used 'management and maintenance' to cover the principle of creating buildings/spaces which are physically devoid of litter, graffiti, vandalism and damage, but are also areas free from stigma or a poor social reputation. It is difficult to assign a specific label to these concepts as image is a state and management and maintenance to the activities that created the state. (Cozens *et al.* 2005)

Activity support

Activity support is concern with the creation of an environment which increases the likelihood that legitimate users will make use of the space and more likely act as additional surveillance. Although activity support is included by many authors as a distinct principle of CPTED, the ultimate aim is to augment surveillance and so, the authors would argue, that the two principles can be merged. (Cozens *et al.* 2005)

Brief Overview of Shopping Mall

A Mall is a specially designed pedestrian environment which comprises certain rules so as to allow people to move about freely and safely (Onibokun, 1975). More also the shopping mall is an enclosed shopping area with streets or public ways in the middle, frequently inside the structure. The use of the word "Mall" to showcase a pedestrianized shopping street originated in

North America in an effort to portray a greater sense of space, quality and elegance than is usually associated with arcade. Malls are usually spaced enough to provide a central area of planting, seating, fountain, furniture another support facilities (Northern and Haskoll, 1977).

Shopping Mall Classification

- Regional centre
- Super regional centre
- Neighbourhood centre
- Lifestyle centres
-

Deductions from literature

From the study the researcher deduces that CPTED as a principle is essential and should be put into consideration right from the beginning of the design to achieve a crime free built environment

The following principles were identified:

- Defensible spaces
- Territoriality
- Surveillance
- Target Hardening
- Access control
- Image/Management
- Activity support

METHODOLOGY

This study adopted a qualitative research design. Data for the study was obtained from the case study. The instruments used for data collection in this study were a structured questionnaire and an observation schedule.

The Fieldwork Observation

A detailed 'observation' of the shopping mall and surrounding areas (including photographic documentation) was performed by the researcher. Using CPTED principles, a template had been developed to check the conditions at these locations—illumination, dark corners, hiding places, clear field of view, transparent materials, presence of objects/barriers, levels of maintenance, formal and informal social control, target-hardening features, social environment and the land use of the immediate environment.

The Questionnaire

A total of 80 people (visitors of the shopping centre) with no distinction of gender, answered a structured questionnaire. This survey was conducted in English. Perceived safety in the shopping centre was measured by different questions asking about:

a. the visitor's own previous victimization;
b. visitor's witnessing events of public disturbance in the shopping mall;

c. the safety of their families and friends (victimisation and perceived safety);
d. particular time and places the visitor felt unsafe in and near the mall.
e. The visitor's overall perceived safety in the shopping mall.

Study Area

Abuja the Federal Capital Territory (FCT) was formed in 1976 from parts of former Nasarawa, Niger, and Kogi States and it is in the central region of Nigeria. Bordered to the north by Kaduna State, to the east by Nassarawa State, to the south-west by Kogi State and to the west by Niger State. It lies between latitudes 80 25'N and 90 20'N and longitude 60 39' and 70 45' East of the Greenwich meridian (NPC, 2006). It covers a land mass of about 8,000 sq. km. (Abuja master plan, 2000) and has a current projected population from NPC, (2006) of 2,514,738 at 3.2 % national population growth rate. The main city is divided into five districts namely, Central Area District, Asokoro District, Garki District, Wuse District, and Maitama District (Figure. I). Its temperature ranges from 30.4^0C and 35.1^0C.

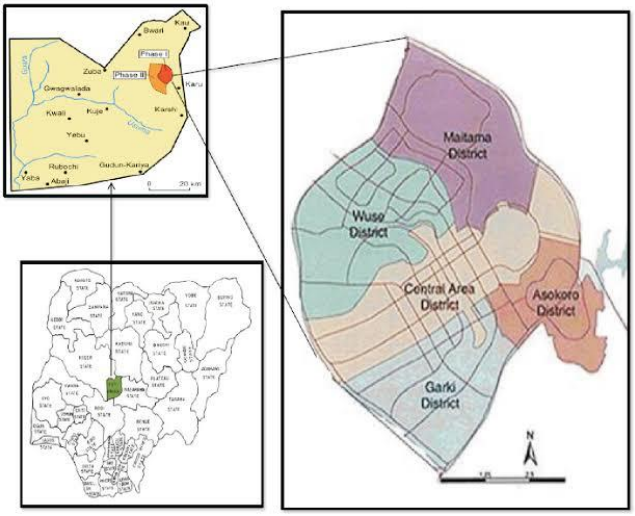

Figure 1: Nigeria showing the study Area
Source: www.iosrjournals.org

RESULTS AND DISSCUSSION

In Ceddi Plaza, the general impression is one of permanence, good maintenance and a well organised amenity that reinforces a sense of care and ownership. In terms of the field observation. The six concepts are briefly discussed below:

i. Territoriality

The Ceddi Plaza is a precinct consisting of freehold allotments, pedestrian thoroughfares and public parking spaces. Spatial delineations are well defined with parking bays, pedestrian thoroughfares; pedestrian walkways. General shop front designs are of good standard. There is street furniture such as seating or ramps for the disabled.

Plate I: Public parking and Pedestrian access
Source: Author`s field work (2020)

ii. Surveillance
All external building corners have limited lines of sight and are constructed from non-transparent materials such as brick or concrete, instead of glazing. Video surveillance is being used inside some shops; there is evidence of CCTV cameras and security guards in public areas. Shop interiors are mostly well-lit with fluorescent security lighting in public spaces.

Plate II: Windows and Surveillance
Source: Author`s field work (2020)

iii. Image management
The Plaza is well maintained, which makes the plaza physically free from litter, graffiti, vandalism and damage and also has no stigma or a poor social reputation

Plate III: Clean Plaza Environment
Source: Author`s field work (2020)

iv. Access control

Ceddi plaza has very good access for pedestrians and also access for vehicles. There is informal pedestrian access between buildings all around the periphery and from the public transport points. Vehicle access is also provided from these heavily-trafficked roads providing continual passive surveillance results from this congestion.

Plate IV: Controlled access
Source: Author`s field work (2020)

v. Target hardening

Most ground floor shops in Ceddi plaza have implemented defensive tactics to combat burglary. This includes chained and padlocked security bars and shutters on windows and doors and most shops have onsite security guards.

vi. Activity support

Ceddi plaza is a commercial precinct with specialist shops and businesses, restaurants, cinema and an internet café among others are accommodated. Generally, Ceddi Plaza has the spatial

fundamentals as a thriving public arena. In addition to these general observations, the presence or absence of CPTED features were audited using a binary, yes/no framework.

Plate V: Activity support (Cinema and Restaurant)
Source: Author`s field work (2020)

In addition to these general observations, the presence or absence of CPTED features were audited using a binary, yes/no framework. Across the six CPTED concepts, 24 questions were used in the audit to record the presence or absence of these elements in the built form.

Each of the elements for each of the CPTED concepts were scored (yes/no) and were recorded, where positive responses scored 1 and negative responses scored 0. As seen in Table I, the Ceddi Plaza scored 18 out of a possible 24 representing a CPTED Audit score of 75%.

Table I: Ceddi Plaza CPTED audit scores

CPTED Theme	Score
Territoriality	3 (out of 5)
Surveillance	6 (out of 6)
Image/management	3 (out of 6)
Access control (and target hardening)	3 (out of 4)
Activity support	3 (out of 3)
Total CPTED Audit Score	18/24 (75%)

Source: Author`s field work (2020)

The data in table I reveal that, overall, the Ceddi plaza Abuja did score high in terms of the presence of several CPTED features. According to the CPTED audit, the built form promotes or uses CPTED concepts very extensively. It scored high in terms of the CPTED concepts of image/management and activity support and there were high levels of territoriality observed at this site. Some evidence of access control/target hardening and surveillance opportunities were most evident in Ceddi Plaza.

The Perceived Safety of the Visitors

As many as 92% of questionnaire respondents declare feeling safe in the shopping centre. The large majority are satisfied with supply of stores and restaurants, food court, cinema, library, and parking lots, but are less satisfied with places like toilets and corridors. Despite being satisfied with their own personal safety, respondents declare worry for the safety of their family and friends in the shopping mall (21% declare feeling worried about them). Those who feel unsafe tend to be more anxious during evening hours.

In Ceddi Mall, only 7 per cent of respondents declare ever having been a victim of crime, with 1% cent having been victimised more than once (Figure I); often in the afternoon and evening; in functional or public spaces, such as stores, restaurants and the food court; and most commonly victims of pick pocketing, theft, violent conflicts and other types of crimes (Figure 2). Furthermore, slightly more than a fifth of respondents had already witnessed a crime happening in the shopping mall (Figure 3) Within the respondent group, pick pocketing is the most common type of crime witnessed, followed by fights, thefts and other types of violence and physical damage.

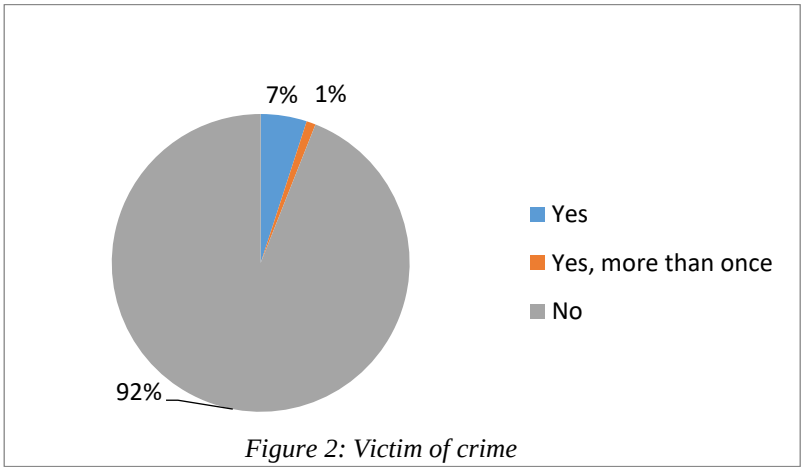

Figure 2: Victim of crime

Source: Author`s field work (2020)

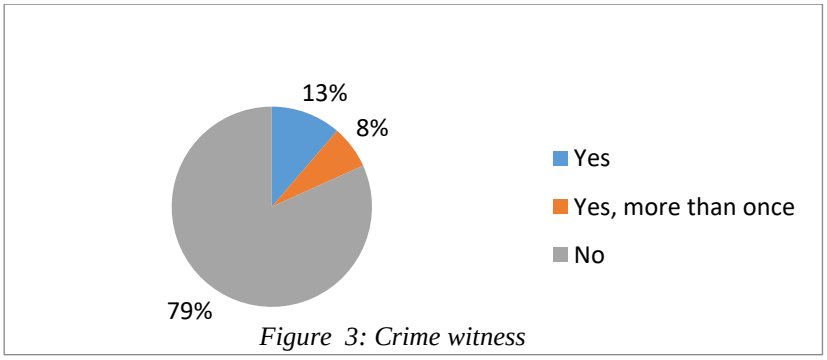

Figure 3: Crime witness

Source: Author`s field work (2020)

The respondents were also asked the types of crime they witnessed in the area. 50% (n=40) perceived pick-pocketing to be an issue. Of slightly less concern were theft (24%, n=20), common nuisance (8%, n-7) and burglary (10%, n=8). Finally, a smaller proportion of respondents felt that assault (3%, n=3), vandalism (4%, n=4) and prostitution (2%, n=2) occurred in the area. (Figure 4)

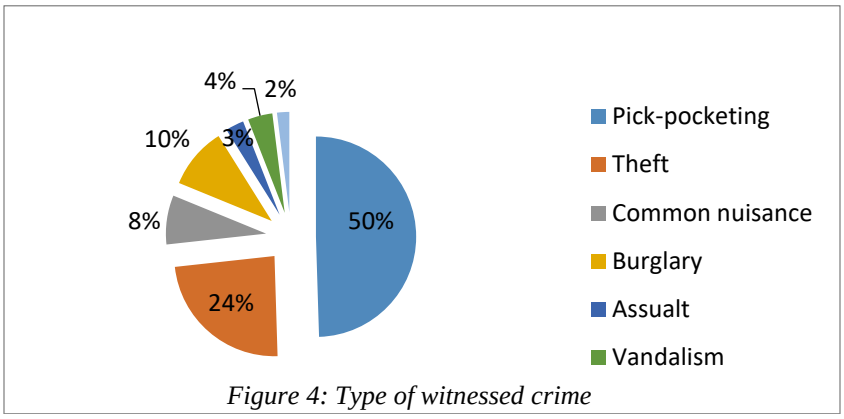

Figure 4: Type of witnessed crime

Source: Author`s field work (2020)

CONCLUSIONS

This paper has explored the perceptions of 80 indigenous Abuja citizens of Nigeria with respect to the concept of CPTED. The findings indicate that traditional CPTED principles are being implemented within the design and built form of this area. The field observation and the perceived safety survey both reported high levels of CPTED features within the environment. These findings suggest CPTED is identified within the environment in similar ways by the field observation and by citizens in the personal safety survey. What is more interesting is that the presence of CPTED equates to high levels of perceived safety. Further research is certainly needed to corroborate these findings using more qualitative approaches such as in depth interviews and focus groups.

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Assessment of Eco-Friendly Principles in the Design of a 3 Star Hotel at Life Camp in Abuja, Nigeria.

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Abstract:
A hotel facility is tasked with providing affordable comfort and services to customers, thus the need for Eco-friendly practices for it plays a key role limiting numerous factors that lead to global warming which poses a big risk to human habitation. The global task for adjusting building structures to the natural environment is sole to meet the world's growing needs, and at the same time limit its impacts on the environment. The review article revealed eco-friendly design principles that are applicable in buildings in Nigeria, and that the application of these principles in Nigeria is not holistic unlike the developed parts of the world where eco-friendly buildings designs are well documented, applied and well adapted ~~to~~. The aim of this study is therefore to assess the Eco-friendly principles in the design of a hotel for its effective application in Nigeria. The methodology adopted includes a desk study of articles related to the study, local Case studies, deducing information regarding eco-friendly and hotel buildings, and field observation to obtain data on some of the selected case studies. The data obtained during the investigation showed that eco-friendly buildings require efficiency in design, choice of material and method of construction. The data was documented, analysed and presented in tables, plates, charts, and figures. The research established that there are eco-friendly design principles applicable to building architecture in Nigeria, which is efficient.

Keywords: Eco-Friendly, Hotel design, Sustainability, Environment.

INTRODUCTION

The word "**hotel"** is derived from the French meaning a mansion or a palace, the hotel industry is a business established in providing lodging services, beverage, and food with other varieties of services that are intended for public service (Essays, 2018). Over the last century, the world has experienced technological revolution and industrialization, during this period the progress recorded mostly was for the sake of social sustainability disregarding the adverse effect to the human within such environment and the planet (Bunz, 2006). Eco-friendly techniques in the context of construction encompasses safety, the quality of living, occupational health and opportunities as a result of future development opportunities (Akadiri, 2012). However, consideration has been taken on the importance of balancing such advancement with future practices, thereby reducing the number of greenhouse gasses released to the atmosphere. Price water house Cooper (PwC) Hotel Outlook for 2018-2022 projected an increase in demand in Nigeria hospitality market to 5.4% annually for the next five years with the existing hotel rooms which has been evaluated to be 9700 in 2017 to 12600 in 2022. The demand in growth can be ranked, as the largest expansion of any country, thus there is the need to adopt Eco-friendly building practice in hotel design.

Burcu (2015), affirmed that a building contains numerous variables that constitute Eco-friendliness, these include choice in landscaping element, materials used in construction, cooling techniques and thermal installation. The built industry plays a major role in the built environment and has a substantial impact on people, their surroundings, the structures, the quality of air and the way of life of occupant, (Abidin, 2012) and it is paramount for the building structure to adopt more

Eco- friendly practices. Eco-buildings are known as organic buildings or green buildings and they have little or no effect on the environment, these types of structures are effective in the use of traditional and recyclable building materials (Gunnell, 2009). Therefore, the aim of this research is to identify the appropriate Eco-friendly building principles used in construction of eco-friendly hotels.

LITRARURE REVIEW

Eco-friendly designs do not mean a loss of quality of life, but requires a change in a mindset in employing alternative approach to traditional design by recognizing the impacts of every design choice on the natural resources of the local, regional and global environments. A model of new design principles necessary for sustainability is exemplified by the "Bill of Rights for the Planet," developed by William McDonough Architects for Expo 2000 held in Hanover, Germany, which includes the following:

- "Accept the responsibility for the consequences of design decisions on human well-being and natural systems."
- "Eliminate the concept of waste. Evaluate and optimize the full life-cycle of products and processes to approach the state of natural systems in which there is no waste."

The World Congress of the International Union of Architects (UIA) adopted these principles in June 1993 at the American Institute of Architects (AIA) Expo 93 in Chicago. This led to a declaration that places environmental and social sustainability at the core of professional responsibility. It also involves educating the building industry, clients, and the general public about the importance of sustainable design. These activities are an example of how the concept of Eco-friendly design is being supported on a global scale. Eco-friendly principles have advanced in response to the knowledge that building structures should have little or no impact on the environment and the natural resources.

Un-Habitat (2006), ascertain the benefits of eco-friendly building practices improves the quality of living, it assist in operation and maintenance optimization, and reduces environment impact thereby protecting the Eco-system. USGBC (2002) affirmed that an Eco-friendly building incorporates the use of sustainable building materials techniques in reducing CO2 emission within a building envelope and the exterior surrounding.

According to Karolides (2002), Eco-friendly building principles and techniques are not an assemblage of 14 environmental' components nor a piecemeal modification of an already designed standard building, rather, it is a building philosophy in which natural and resource efficient features are integrated in a building. The principles and techniques of eco-friendly building therefore are theories and practices in the construction industry that serve as the criteria for evaluating the impacts of the building project. The World Business Council for Sustainable Development WBCSD (2000) initiated The idea of Eco-efficiency building practices in 1991 it includes ''the development of products and services at competitive prices that meet the needs of humankind with quality of life, while progressively reducing their environmental impact and consumption of raw materials throughout their life cycle, to a level compatible with the capacity of the planet''. Eco-friendly building material practices is a growing field, it brings about new innovative product to choose on yearly bases. The materials that have been discovered and used in construction have been known to emit harmful gases that affect inhabitant, and they contribute to a decline in healthy

living. The selection of the desired building materials is a complex procedure that involves several variables, through which several characteristics can been recognized in various construction materials which are;

- Reusability /recyclable
- Durability
- Environmental impact

Other criteria include the listed items below

- Energy Efficiency and Conservation
- Water Efficiency and Conservation
- Material Conservation
- Waste management
- Humane Adaptation

Energy Efficiency and Conservation

Gillingham *et al*., (2009) defines energy efficiency as the energy services provided per unit of energy input and energy conservation as the total reduction in the amount of energy consumed. Buildings consume energy and other resources throughout its life cycle, from design and construction through operation and demolition (Schumacher et al., 2011).

According to Lockwood (2006), an eco-friendly building can help generate 40% more savings from energy conservation and perform 40% better than traditional buildings (Lockwood, 2006). Improving the energy efficiency and energy conservation of a building will reduce the emissions of carbon dioxide (US Department of Energy, 2008). Carbon dioxide is an important source of energy for plant growth but too much of it is harmful to both plants and humans, this means that high CO_2 emissions from buildings are not environmentally friendly.

Therefore, it is advisable to cut the consumption of energy by using renewable energy sources such as solar, wind or water turbines.

Water Efficiency and Conservation

Energy used to pump water and distribute to all sections of the building entail treatments and delivery which consumes energy (Kim and Rigdon, 2008). The increase of water efficiency will result in decreased waste production from water treatment, thus improving environmental sustainability. Excessive water use in buildings therefore means excessive use of energy, which will increase gas emissions endangering the environment. Water efficiency basically looks at the 5R principle as asserted by (Silva-Afonso and Pimentel-Prdrigues, 2011). These are i) reduction in consumption, ii) reduction in loss and waste, iii) re-use of water, iv) recycling of water and v) resorting to alternative sources.

In the long run, conserving and using water efficiently will result in energy savings and a reduction in greenhouse gas effects on the environment (Silva-Afonso and Pimentel-Prdrigues, 2011).

Material Conservation

Eco-friendly buildings are infrastructures constructed with recyclable, renewable, reusable and nontoxic materials that have zero or low volatile organic compounds (VOCs) (US Department of

Energy, 2008). It is because of this that Akadiri et al. (2012) insists that material conservation should take into consideration i) design for waste minimization, ii) specification of durable materials, iii) specification of natural and local materials, iv) designing for pollution prevention and specification of non-toxic or less-toxic materials.

Ljungberg (2007) defines renewable materials *as* materials, which are formed again in a short time and give no or very little impact on the environment. In his view, wood for example is preferable to plastic since it can be renewed in a shorter time when compared to plastic also, Gustavsson and Sathre, (2006) stated that the use of wood for construction generally results in a lower energy consumption and carbon dioxide emissions. Furthermore, when the tree is burnt its ashes can be used as organic manure. This means the use of wood materials for buildings are environmentally sustainable compared to plastic materials.

Local, materials like straw, laterite, mud, bamboo, wood, etc. are renewable materials that if used helps to create a healthier and safer environment. Aside these, the use of local materials save on transportation energy (Kim and Rigdon, 2008).

Waste Management

Treatment of the waste has been a major environmental issue. Reuse, reduction and recycling of waste are considered as viable methods of recovering waste (Tam and Tam, 2006). Designers have a significant role to play in the reduction of waste by focusing on designing out waste (Osmani et al., 2008). By this, the waste management ought to be considered at the design stage. It is for this reason that materials specified in design to be used for the construction should be reusable or recyclable and as much as possible waste reduced or eliminated. It is important to note that recycling of building waste can greatly reduce the need for energy and natural resources, at the same time decreasing the amount of materials to landfill sites (Thormark, 2006). An example is the use of aggregates from recycled construction for concrete (Rao et al., 2006).

Humane Adaptation

Designing for humane adaptation looks at protecting human health and comfort as well as the protection of physical resources (Akadiri et al., 2012). One of the things to consider when designing to preserve the natural conditions is the topography of the site, the vegetation and the water table. Buildings should also be designed bearing in mind the climatic conditions of the area in which the site falls (Omer, 2008).

To achieve proper design for comfort, Kim and Rigdon (1998) phrases the methods of designing for human comfort as i) provision of thermal, visual and acoustic comfort, ii) provision of visual connection to the exterior, iii) provision of operable windows, iv) provision of clear fresh air, v) utilisation of non-toxic materials. (Akadiri et al., 2012) rephrases six major methods of achieving design for human comfort as i) thermal comfort, ii) acoustic comfort, iii) day lighting, iv) natural ventilation, v) aesthetics and vi) functionality. The above-mentioned methods help people to perform well in the building. Good lighting, acoustic privacy and thermal control are the key to occupants' productivity and satisfaction

The concept of eco-friendly principles can be useful at various levels in building and planning ranging from residential buildings, to neighbourhood or estate and industrial parks.

Ecological design solves many environmental problems by the simple application of passive architectural systems integrated into the built form (Bidoki, 2016). Much progress has been made in this regard however, it is paramount in considering Eco-friendly practices in both constructional and operation phase in any given building facilities. The natural environment is like a human body, it can metabolize nutrients and waste whereby those that are useful are absorbed and unsafe elements are discarded. Eco-construction focuses on these processes, integrating ecological functions into the buildings to catch, store and filter, purity and processes other nutrients (Ragheb, El-Shimy, & Ragheb, 2015). Other examples include;

- The land can be optimized by avoiding sprawling building designs and by efficiently allocating internal space to various needs.
- Energy use can be reduced by passive or active solar heating technologies, use of shading overhangs and reflecting surfaces in summer and efficient insulation, windows, light and appliances; externally, trees can be planted or positioned to adequately provide shade.
- In urban areas dominated by high rise buildings, use of green roof is an Eco-friendly solution, green roofs last longer than conventional roofs, reduce energy costs with natural insulation, create peaceful retreats for people and animals, and absorb storm water, potentially lessening the need for complex and expensive drainage systems and cooling system.
- Landscaping can be naturalized by utilizing existing topography and only native plants in horticulture to emulate natural communities appropriate to local conditions while still maintaining pleasant aesthetics and low-impact recreational use (Yang, 2002).
- Building materials and furniture can be selected or specified to be efficiently manufactured from renewable resources, durable yet reuse or recycled and not to emit indoor pollutant.
- Traditional or vernacular design elements can be incorporated into buildings to improve their energy and material efficiency, aesthetics and comfort while still respecting cultural heritage.
-

Urban planning

Eco-principles can be applied to the development of existing town and communities as well as in the development of modern cities. According to Olomolaiye *et al.* (2012), improvement of existing urban areas starts with identifying the ecological problems such as inadequate on the right choice in materials applications, lack of technical knowledge in applying modern innovative building technique in Eco-design, climatic condition that are attainable for a particular building material, transportation distances, inadequate organization between the factions within the built industries or in the use and neglected resources commonly known as waste. Lastly, other ecological challenges include; environmental waste conflicts with indigenous biodiversity. Tiezheng (2002), added that, other factors to consider and dealt with include travelling distances, the growth of sparingly integrated districts and equity issues. These enhancements can be addressed into structures that are in existence when it is re-designed.

METHODOLOGY

To achieve the study's objective, hotel buildings were targeted for the research; a descriptive research method was used in this study. It involved a case study approach, where observation schedule was use to solicit data and desk study approach was applied on the subject matter. The qualitative research methods recognize the variables and their relationship, the case study assist the researcher in examining various environmental practices adopted in each building that selected for study. The building physical characteristics, building element, site organization was amongst the data to be obtained from the desk study.

The study population comprises hotel building in the Federal Capital Territory, Abuja and the subject matter covers the area of interest within the building and all result gotten can be generalized with various characteristics. The research made use of random probability sampling techniques; with a purposive selection method where building types were selected after cautious deliberation that suits the study of interest. The total numbers of hotels contacted for this research are Five (5) and Twenty-five-person (25) were interviewed at hotel venues and five (5) people that sales building materials.

FINDINGS AND DISCUSSIONS OF RESULTS

The data obtained using a case study approach are checked on the basic principles and practices of Eco-friendliness in the built industry and was represented in the form of charts, plates, tables and figures. The investigation was directed to field survey and observations were duly noted, analysed and the results are compared in identifying Eco-friendly principles and techniques in hotel buildings, which are:

a. Identifying the Eco-friendly building techniques.
b. Accessing the adequacy Eco friendly building techniques employed

The data analysed was on the bases of the following variable, which include:

- Choice of building material
- The use of landscape element
- Cooling and natural ventilation
- Solar control
- Green roof technology and Traditional or vernacular design elements.

Choice of Building Material

Table 1. Shows the types of building material used for construction as extracted from the observation schedule of the research carried out.

Table 1: Material used for construction.

s/no.	Hotel Name	Location (Abuja)	Materials used for Construction
1	Nera Hotel	Jabi lake	Concrete, Sancrete blocks, Bamboo
2	Starview Palace	Gwarinpa Estate	Concrete, Sancrete blocks
3	Crossover Suite	Gwarinpa Estate	Concrete, Sancrete blocks
4	Sefcon Suites and Apartment	Gwarinpa Estate	Concrete, Sancrete blocks
5	Ivana Suite	Wuse 2	Concrete, Sancrete blocks

Landscape Element

Table 2. Below shows poor integration of soft landscape element as seen on the observation schedule carried out on the study area, less emphasis was given to tree planting while grasses was employed on most site. The data collected shows that one (3) building made use of tress, three (5) building made use of shrubs and three (2) of the five (5) building made use grass which were planted around the buildings for heat absorption.

Table 2: Showing landscape element

s/no.	Buildings	Trees	Shurbs	Grass
1.	Nera hotel	✓	✓	✓
2.	Starview Palace	✓	✓	—
3.	Crossover Suite	—	✓	—
4.	Sefcon Suite and Apartment	—	✓	—
5	Ivana Suites	✓	✓	✓
	Total	3	5	2

Cooling and natural ventilation

Table 3. Shows the use of both natural and mechanized cooling techniques in achieving energy efficiency in the buildings as extracted from the observation schedule of the buildings studied.

Table 3: Showing Cooling means

Buildings	Mechanized	Natural
Nera hotel	✓	✓
Starview Palace	✓	—
Crossover Suite	✓	—
Sefcon Suite and Apartment	✓	—
Ivana Suite	✓	✓
Total	5	2

Solar Control

Table 4. Below shows the different measures adopted in solar control used in buildings as extracted from the observation schedule of the research carried out. The method adopted in the five (5) buildings is window blind fixed internally while they were no application of tinted glasses or the use of both horizontal and vertical shading devices.

Table 4: Solar control devices employed

Building	Internal shading	External Shading	Tinted Windows
Nera hotel	✓	—	—
Starview Palace	✓	—	—
Crossover Suite	✓	—	—
Sefcon Suite and Apartment	✓	—	—
Ivana Suite	✓	—	—
Total	5	0	0

Green roof technology and traditional or vernacular design element

Table 5 below shows poor integration of Green roof technology and traditional or vernacular design element on the observation schedule on the study area less emphasis was given to tree planting while grasses was employed on most sites.

Table 5: Solar control devices employed

Building	Green roof technology	Traditional or vernacular design element
Nera hotel	—	—
Starview Palace	—	—
Crossover Suite	—	—
Sefcon Suite and Apartment	—	—
Ivana Suite	—	—
Total	0	0

Further Criteria used for the study are tabulated below

The results obtained from the study are presented below in tabular format. Visiting the selected structures in Abuja and Lagos collected data for this research. The data attained was examined using descriptive analytical methods. Each of the samples was tested against eco-friendly building criteria and sub-criteria.

S/no	Criteria	Case study 1	Case study 2	Case study 3	Case study 4	Case Study 5
1	Energy efficiency and conservation (A)	∗	✓	X	∗	X
2	Water efficiency and conservation (B)	✓	✓	X	∗	X
3	Material Conservation (C)	X	∗	X	X	X
4	Waste management (D)	∗	∗	X	∗	X
5	Humane Adaptation (E)	∗	✓	∗	∗	∗
	Percentage (%)	67%	87%	40%	60%	40%

Table 6.0 shows the adoption of eco-friendly building criteria in the construction

The symbols adapted are as follows;

Absent =X, ___ Present = ✓ Average = ∗

From Table 6.0, Case study 1 recorded a 69% application of the criteria with high water efficiency through a reduction in the waste of water, use of water efficient landscaping, reuse and recycling of water. It has average energy conservation, waste management and humane adaptation. Case study 2 recorded an 87% implementation of the criteria, with high water efficiency like Case study 1. It however shows higher Energy efficiency, conservation and humane adaptation due to low operational energy and use of renewable energy sources and an average waste management process because only some of the waste is recycled. Case study 3and 5 recorded a 40% adoption of the criteria. Both structures were designed and built without putting the environmental impact of the structure into consideration; therefore both buildings have low energy efficiency and conservation, inadequate water and material conservation, and poor waste management. Both buildings show an average humane adaptation, in the building design. Case study 4 shows 60%, a near average implementation of the criteria for eco-friendly design. All the case studies excluding Case study 2 show poor material conservation, because of inadequate recycling and reuse of materials and a

negligence in the use of non-toxic building materials especially in the indoor environment. There is also an overall average to poor management of waste in the construction of all the buildings.
A total number of thirty (30) people were interviewed, five (5) from each hotel establishment and five (5) building material sale personal at Die-Die building market

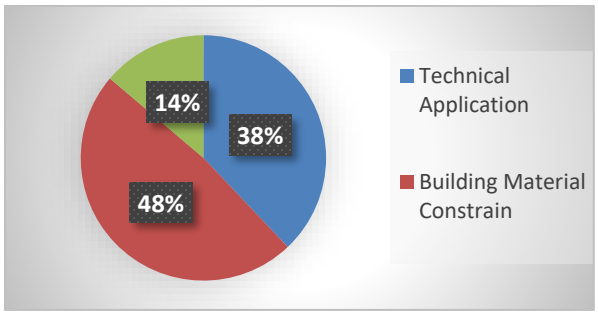

Figure 1: Challenges in the use of Eco-friendly principles and application

Overall, the people consulted stated that the lack of skilled personal in the field is responsible for decline in buildings that Eco-friendly; they went further in stating that this is a problem. The vast majority said that the type of building material is a main problem due the limitation in innovation in Abuja. They further stated that in Nigeria most building material are not Eco-friendly and the available one is either expensive or not readily available, the minor segment, which amounts to 14%, blamed it on the lack of knowledge on Eco-friendly principle.
Figure 2 illustrate that the vast majority of the individuals consulted agreed that there is no risk in the application of Eco-friendly principles in building and building built with theses are more durable, while 17% had no precises answer as to the impact be it negative nor positive and the minority which is 10% said there are risk in involved in the application stating that the right choice of building materials are the limitation hindering the application of Eco-friendly techniques in the State.

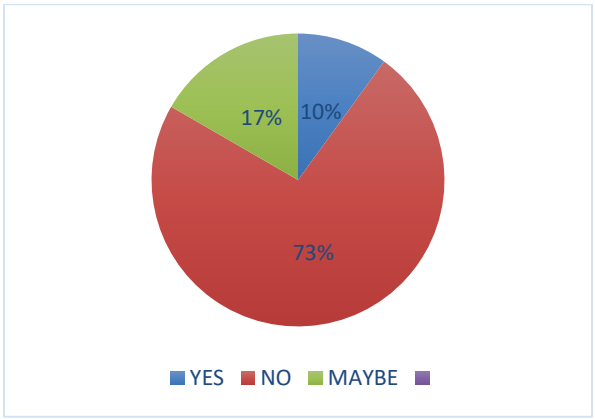

Figure 2: Risk in Eco-friendly principles and application

CONCLUSIONS

This research shows that Eco-friendly building practices is not limited to the planting of trees and shrubs, it cut across all aspects of the building process from that choice the of building material to

the mode of construction and techniques employed in achieving eco-friendliness. Therefore, Eco-friendly practices must be adhered to from the design stage to the construction process.
The government should educate building practitioner on the negative impact in erecting structures that are not Eco-friendly, The built industry should implement and enforce rule that prevents investors from embarking on any given development without considering the environmental impact in material choice and application.

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Climate Change Adaptation and Sustainable Eco-Friendly Urban Mass Transit Development in Abuja, Nigeria

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Abstract:
In the present century, there has being increasing global pressure on governments to implement policies to incentivize reductions in CO_2 emissions in view of the devastating effects of the global climate change. Researches generally have established the fact that the automobile sector generates more than 50% of the atmospheric carbon concentration. It has also become obvious that FCC-Abuja Nigeria is merely a replica of Lagos transport-wise in all ramifications. The Abuja master Plan as of 1979 specifically recommended the development of mass transport by light-rail when the city inhabitant is about 1.6 million and 3.1 million for Airport. The none implementation of the light rail in the city as at when due has aggravated the flood of vehicular traffic that generate a lot of Green House Gas that in-turn increase the city ambient temperature. This research therefore used the handheld outdoor thermometer to measure the traffic corridors in Abuja in relation to the WHO and FEPA tolerance threshold standard. This is compared with the modern electric rail that is environmentally friendly, and the result reveals that the present transport system in the city negate the global crusade for Green Mobility. It is therefore recommended that the federal government of Nigeria should as a matter of urgency seize from her lip-service to the global SDGs and fully implement the overdue Abuja light rail that will positively woo the other cities of the federation.

Keywords: *Temperature, Climate Change, Mass-Transit, Light-Rail, Transportation.*

1. INTRODUCTION

Globally, there has being a growing scientific consensus on the need for governments to implement policies that incentivize reductions in CO_2 emissions. Apart from instrumental temperature measurements as an evidence of increasing global temperatures, the observed increased melting of glaciers and loss of polar-ice cover can be used to estimate the rate of temperature increase since the late 19thcentury. Estimates of near-surface temperature based on glacial melting are very similar to estimates based on instrumental temperature data. A 15 to20 percent reduction in Arctic sea ice, 10 percent decrease in snow cover since the 1970s, and shortened periods of lake and river ice cover have been observed. Also, ocean heat content has significantly increased over the past several Decades. Storm surge is the abnormal rise in sea level accompanying a hurricane or other intense storm, above the level of the normal or astronomic tide (IPCC 2007).

A small proportion of the atmosphere is, and long has been, composed of GHGs (water vapour, carbon dioxide, ozone, and methane). These gases effectively prevent part of the heat radiated by the earth's surface from otherwise escaping to space. Some GHGs are proliferated in the atmosphere because of automobile and human activities and increasingly trapping more heat (Morris *et al,* 2001; Robert *et al,* 2010). Direct atmospheric measurements made over the past50 years have documented steady growth in the atmospheric abundance of carbon dioxide (CO_2). Today GHGs are the largest human influence on atmospheric composition. The increase in GHG concentrations in the atmosphere implies a positive irradiative forcing (i.e., a tendency to warm the climate system).

Increases in heat-trapping GHGs are projected to be amplified by feed-back effects, such as changes in water vapour, snow cover, and sea ice. As atmospheric concentrations of CO_2 and other GHGs increase, the resulting rise in surface temperature leads to less sea ice and snow cover,

causing the planet to absorb more of the sun's energy rather than reflecting it back to space, thereby raising temperatures even further. Present evidence also suggests that GHGs lead to rising temperatures and evaporation, (IPCC 2007). If projected climate changes push environmental conditions outside the range for which a country system was designed—and the scientific evidence surge, then there will be environmental catastrophes that must be managed and adapted. This study focused on the atmospheric implications of over vehicular traffic concentration and none implementation of the light-rail in Federal Capital City of Abuja

2. REVIEWED LITERATURE

The question that readily comes to mind is 'what warms and cools the earth? The sun is the earth's main energy source that is constant, but small changes during an extended period of time can lead to climate changes. Greenhouse gases such as: Water vapour (H_2O), Carbon dioxide (CO_2), Methane (CH_4), Ozone (O_3), Nitrous oxide (N_2O), and the continued use of Halocarbons as substitutes for chlorofluorocarbons (CFCs) in refrigerant fluids and as aerosol-package propellants hangs in the atmosphere,(Forster et al. 2007).

The respective roles of human and natural causes in these changes have now been well established (IPCC 2007b).Numerous studies have examined the link between climate change and the transportation sector. Studies conducted primarily from the perspective of transportation's contribution to global warming through the burning of fossil fuels, which releases carbon dioxide (CO_2) and other greenhouse gases (GHGs) into the atmosphere. CO_2 from combustion of fossil fuels is the largest source of GHG emissions. The challenging question that the answer is not far fetch is; why should transportation professionals take note of climate change? First, it is not just a problem for the future. Recent changes, such as global warming and resulting sea level rises, reflect the effects of GHG emissions that were released into the atmosphere over the past century. What appears to be new is the greater certainty of scientists that human activity is already warming the climate and that the rate of change is likely to be greater than at any time in modern history (IPCC 2007b, 2013).

Second, climate change will not necessarily occur gradually. Climate scientists expect that higher temperatures will be amplified by normal variability in climate, leading to new extremes far outside current experience [e.g., the heat wave in Europe in 2003 (Stott et al. 2016) and the near record heat of 2006 in the United States.

Third, although transportation professionals typically plan 20 to30 years into the future, many decisions taken today, particularly about the location of infrastructure, help shape development patterns and markets that endure far beyond these planning horizons. Similarly, decisions about land use, zoning, and development often create demand for long-lived transportation infrastructure investments. Thus, it is important for transportation decision makers to consider potential impacts of climate change in making these investment choices because those impacts will affect how well those infrastructures contribute to climate change mitigation and adaptation.

Fourth, professionals in many fields—among them finance, building (where protecting against earthquakes, wildfires, or wind risk is a concern), nuclear power, and water resources (in the design of dams and canals)—are continually making decisions in the face of uncertain information about risks and outcomes. In addressing climate change, more quantitative assessments, such as the development of probabilistic climate change scenarios at the level of geographic and modal specificity needed by transportation planners and engineers, which can be incorporated into

planning forecasts and engineering design guidelines and standards (Ali S. and Elsan S. 2017; Gonzalez et al 2005).

Finally, transportation professionals already consider weather- and climate-related factors in designing and operating the transportation infrastructure. For example, many transportation networks and facilities are designed with adequate drainage and pumping capacity to handle a100-year storm. Materials and maintenance cycles are geared to assumptions about temperature and precipitation levels. Thus, economic activity is projected to produce greenhouse gas emissions throughout this century. Exponential increase in human activities now exert pressure on land use/ water resources, fossil fuels utilization and natural resources (Van Asselen et al.,2013; Avis et al., 2011). These emissions of greenhouse gases causes the Earth surface to warm, and, in aggregate, the effects of global warming are expected to be deleterious and harmful to global welfare systems, Comrier (2000).

The human body has on average, a normal body temperature of 98.6˚F (37˚C). To maintain this temperature without the help of warming or cooling devices, the surrounding environment needs to be at about 82˚F (28˚C). High environmental temperatures can be dangerous to human body. In the range of 90˚ and 105˚F (32˚ and 40˚C), one can experience heat cramps and exhaustion. Some common symptoms of heat exhaustion already experience in FCC as in Lagos include:

i. sweating heavily
ii. exhaustion or fatigue
iii. dizziness or light-headedness
iv. blacking out or feeling dizzy when standing up
v. weak but fast pulse
vi. feelings of nausea

Mass transport by hybrid rail is already attractive for its carbon efficiency, for example direct CO2 emissions per passenger km from London Underground (LU) are around one third of what is typical for a single occupant car (DEFRA, 2013). Global sales of electric cars (plug-ins) are up by 63 percent, topping two million units. Forecasts predict vehicles with at least some type of plug-in capability will account for nearly half of global auto sales by 2040 Tom (2019). In California and San Diego, it has being established that even though they are in love with their cars and driving to work is a precious right as far as most of them are concerned, if given a pleasant alternative, a large number of them will take advantage of it to get to work.

According to NRC (1982, 2008), North America Committee on Light Rail Transit defined this mode of urban transportation based on thoroughly proven electric railway technology as:

> *"Light rail transit is a mode of urban transportation that uses predominantly reserved, but not necessarily grade-separated, rights-of-way. Electrically propelled vehicles operate singly or in trains. Light rail transit provides a wide range of passenger capacities and performance characteristics at moderate costs".*

This definition clearly reveals the overriding benefits of light rail above other urban means of mobility like Buses and justifies the centrality of national investment on it.

2.1 The Concept of Smart city in urban mobility

Although the costs of carbon-free energy such as wind and solar have come down dramatically over recent decades, there are substantial challenges to completely decarbonising our electricity

system, and even greater challenges to completely decarbonising the transportation and industrial sectors (Davis SJ, et al. (2018).

A smart city is an urban development using Information and Communication Technology (ICT) and Internet of Things (IoT) to provide useful information to effectively manage resources and assets. This includes data collected from citizens and mechanical devices, which are processed and analyzed to monitor and manage traffic and transport systems, power plants, water supply networks, waste disposal, etc. The smart city aims to improve the quality of urban services or reduce its costs. It stands out for its specificities: smart management, lifestyle, mobility, housing, as well as a smart economy. It is also to reconcile technological innovation with the economic, social and ecological challenges of the city of tomorrow. Their leitmotiv is the quality of life: how to live better together while respecting our environment. For instance, the advancement of smart cities and communities is critical to realizing Japan's vision for Society 5.0. It is also essential to addressing the world's most pressing challenges, including climate change and inclusive economic growth," said Koichi Akaishi, Vice Minister for Science, Technology, and Innovation for the Cabinet Office of the Government of Japan. According to Chizuru (2019), as urban populations grow, smart city technologies become more and more essential not only to improve the quality of life of citizens but also to simply keep our cities liveable. When considering smart cities in places like Asia, fundamental urban challenges such as low-carbon transport systems is of exceeding importance.

Reducing the CO^2 footprint is the main driver behind the development of smart and sustainable cities. Improving energy efficiency and storage, waste management, traffic conditions are among the greatest advantages. Smart grids and smart water management are recurring themes of smart cities. Energy consumption and potable water monitoring ensure the availability of energy and the quality of tap water across the city. Clean and efficient transportation of goods, services and people is essential. In the hope of optimizing mobility, many cities are turning to smart technologies to ease traffic congestion and provide users with real-time updates.

2.2 The Concept of green mobility and Light-rail

Light rail or light rail transit (LRT) is a form of urban rail public transportation that generally has a lower capacity and lower speed than heavy rail and metro systems, but higher capacity and higher speed than traditional street-running tram systems. The term is typically used to refer to rail systems with rapid transit-style features that usually use electric rail cars operating mostly in private rights-of-way separated from other traffic but sometimes, if necessary, mixed with other traffic in city streets as displayed in Figure 1.

Figure 1. Typical electric powered Light rail in Algeria and South Africa.

The key attributes of LRT service include: use of exclusive rights-of-way, exclusive lanes in the medians of roadways, and stations are spaced further apart than with bus service, typically every half mile (although stations are often spaced more closely within downtown areas).

2.4 Aim and Objectives of study

The aim of this study is to assess the environmental implication of the none-implementation of Abuja light-rail as proposed by the first master plan in relation to the green mobility crusade and the global Climate Change. This is to be achieved through the following objectives:

i. Examine the importance of light-rail as urban mass transit and sustainable development strategy,
ii. Assess and map the vehicular heat emission level along the major transport corridors in Abuja,
iii. Assess the environmental implication of the road corridor temperature in relation to ambient air temperature standards, and recommend planning solutions

3 THE STUDY AREA

Geographically, the Federal Capital Territory (FCT) lies between latitude 8^0 25' and 9^0 20; North of the equator and longitude 6^0 45; and 7^0 39; East of the Greenwich meridian, with a land area of about 7315 square kilometre, see figure 2. The unofficial metropolitan population of Abuja is well over 3,000,000, but the population as at 2012 is 2,245,000 making it the fourth largest urban area in Nigeria after Lagos, Kano and Ibadan.

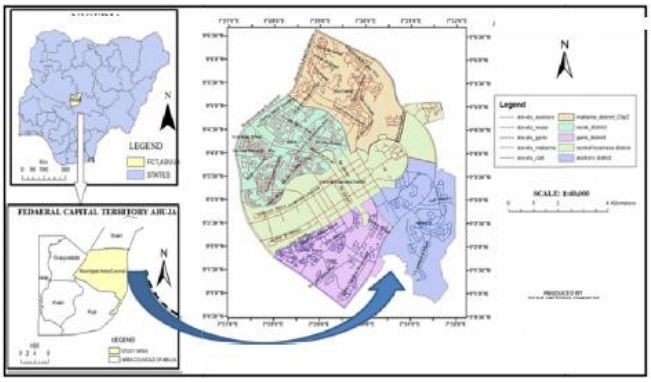

Figure 2.Study Location, FCC-Nigeria.
Source: Adapted from Ayo et al (2014)

3.1 Methodology

In carrying out this study, the entire city was divided into quadrants of convenience, and the major roads were selected for survey nodes. On each of the roads, three (3) different locations were identified where outdoor temperature readings were taking along the roads using handheld digital thermometer held at about two meter altitude. The readings captured the road corridor temperature during the peak periods of 7am to 10am, 12pm – 1pm and 4pm – 7pm.

A geo-referenced map of Abuja was acquired and a hand-held Garmin 78 model Global Positioning System (GPS) was used to determine the survey nodes coordinates that was used to

carry out the mapping in ArcGIS software, see figure 3. The corridor temperature readings were compared with the surrounding environment to determine the differences.

Figure 3 Digital handheld outdoor thermometer and GPS

3. 2 Status of vehicular growth and pollution scenario in Abuja

The National Bureau of Statistics revealed that as at the third quarter of 2017, Nigeria had about 11,547,236 motor vehicles in the country. About 4,656,725 of these vehicles are privately owned while, 6,749,461 vehicles are registered as commercial vehicles. Another 135,216 vehicles are registered as government owned vehicles while 5,834 vehicles are registered for diplomats. Nigeria's vehicle per person is therefore 0.06 as at the third quarter of 2017.This presents huge opportunities for local vehicle production and assembly in Nigeria. For instance, the rate of motor vehicle ownership and use is growing faster than population in many places, with the vehicle ownership growth rates rising to 15 to 20 percent per year. (Odeleye 2008). As at the third quarter of the year 2017, data from the National Bureau of Statistics (NBS) reveals that Nigeria has a total vehicle population of about 11,547,236., (see Figure 4 for Nigerian urban vehicles).

Figure 4: Typical Lagos and Abuja urban traffic scenes.

3.3 The Abuja Master Plan and the light rail development

Population growth of the Federal Capital City (FCC) at the onset only support initial development of bus transit services on the spine transit ways. In economic terms, operation of light rail does not begin to become attractive until hourly volumes of 6,000 or more passengers are reached according the master plan. These volumes correspond to 60 or 70 percent of the population of 1.6 million inhabitants in the capital city. The population of Abuja based on the 2006 population estimate,

the projected population of the FCC is 2.4million, while the metro estimate is 6million as at 2011 As of 2015, the city was experiencing an annual growth of at least 35%, retaining its position as the fastest-growing city on the African continent and one of the fastest-growing in the world. As of 2016, the metropolitan area of Abuja is estimated at eight million (8,000,000) persons, placing it behind only Lagos, as the most populous metro area in Nigeria. The evolutionary transit system of Abuja is long overdue for conversion into light-rail system going by the master plan proposal; see figure 5a and 5b for the proposed corridor design.

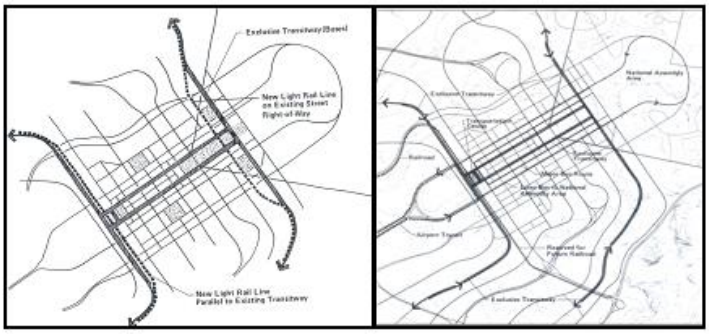

Figure 5a Interconnected light rail Figure 5b Central Area Public Corridor and Buses Transportation system Figure

4. Implementation of Light rail in Abuja

The Abuja Light Rail was first commissioned in 2007 by former President Olusegun Obasanjo as the first light rail network in west Africa, The Light Rail begun operation, after undergoing 11 years of construction through four Presidents. The project gulped a total of $831million. The 45 kilometre rail connects the city to the Nnamdi Azikiwe International Airport, and links other parts of the city to ease transportation. The China Civil Engineering Construction Corporation (CCECC) handled the project and was to have delivered the first phase of the project last year. The entire system wholly depends on fossil fuel power as against the electric system in even Ethiopia and others.

What was implemented in standard is far below the 21st century light rail in comparison to ~~even in~~ other African Countries like ~~thatof~~ Ethiopia in term of the conveyor and the electric power infrastructure as revealed in figure 5. The Abuja-Kaduna standard gauge rail is not yet environmental friendly in term of power source. Modern rails are expected to operate on electric power, Solar or Hydrogen cell as in Ethiopia.

Figure 5.Rail transit in Nigeria and other African countries in the 21st century.

Light-Rail system has lotsof advantages above other commuter modes of transport that should move a country like Nigeria to readily adopt and implement without lip service and politicking.

When it comes to System cost, Scheduling and reliability, Public comforts and social acceptability, light-rail is rated higher comparatively as revealed in Table 1.

Table 1.Key Characteristics Differentiating LRT from other Transit Modes

Characteristic	Light Rail	Bus	Commuter Rail	Automated Guide way	Rapid Rail*
System Costs:					
Initial	Moderate	Low/moderate	Low-to-high	High	Very high
Operating & Maintenance, per Passenger Mile(b)	……..	Higher	Higher	Similar	Lower
Attributes:					
Schedule Reliability	Excellent	Fair	Good	Superior	Excellent
Grade Separation	Varies	Loss	More	100%	100%
Automatic Operation	No	No	No	Yes	Maybe
Entrained Vehicles	Yes	No	Yes	Maybe	Yes
Public Perception:					
Comfort, Ride quality	Good	Fair	Good	Good	Good
Route Comprehension	Easy	Hard	Easy	Easy	Easy/Hard
Social Acceptability	High	Low	High	High	
Railroad Involvement					
Operating Labour	No	No	Yes	No	No
Freight Coordination	Maybe	No	Maybe	No	No

5. RESULT AND DISCUSSION

5.1Meteorological aspects of air pollution and human health

To repeat the words of Bob Patricelli, light rail should not be considered a panacea for the growing woes created by our increasing urban congestion. But, in the right corridors, it is the right answer to the needs of a lot of commuters as it can make their lives more pleasant, make the cities where they live more vital and interesting places. And it can contribute to the quality of the air they breathe. Abuja has turn out to be replica of Lagos in term of transport system and its woes. Atmospheric pollution is a widespread problem in Nigerian urban cities and is caused primarily due to fossil fuel combustion at point and none point sources, Jaiyeola (2019). Due to inadequate mass transit system in the major cities like Abuja, the use of personal vehicles has continued to be on steady increase.

5.2Mapping of the Abuja route corridor temperature

Mapping of Urban Heat Island (UHI) is a modern technique in addressing urban temperature challenges as carried out by researchers like Heislex (2007). The major streets in Abuja were selected, and temperature readings were taking simultaneously to determine the variation in the ambient temperature from the surrounding areas. Based on the field temperature readings, the streets were grouped into five, and Aminu Kano, Sani Abacha, Kashim Ibrahim, Ademola

Adetokunbo, and Herbert Macauly ways has the highest temperature range of 31.3^0C – 34.2^0C as display in table 2. The same data was imported into the ArcGIS to produce the map in figure 7.

Table 2.Abuja urban road temperature classified

S/N	24.2°C - 26.0°C	26.1°C – 28.4°C	28.5°C – 29.9°C	30.0°C – 31.2 °C	31.3°C – 34.2°C
1	Ahmadu Bello Way	AlvanIkoku Way	AguiyiIronsi Street	IBB Way	Aminu Kano way
2	NnamdiAzikwe	ShehuShagari Way	ShehuShagari Way	IBB Way	SaniAbacha Way
3	Ahmadu Bello Way	Independence Avenu	AguiyiIronsi Street	AdemolaAdetokunbo	Kashim Ibrahim Way By Wuse
4	Ahmadu Bello Way	LadokeAkintola	SaniAbacha Way		Adetokumboroad
5	MuhammedBuhari Way	Obasanjo Way	AguiyiIronsi Street		Herbert Macaulay Way
6	LadokeAkintola way	By TafawaBalewa Road	IBB Way By Ahmadu Bello		
7	Murtala Mohammed	MashoodAbiola Way	Constitution Avenue		
8	Independence Avenue	FunmilayoRansomeKuti	TafawaBalewa Opposite NICON		

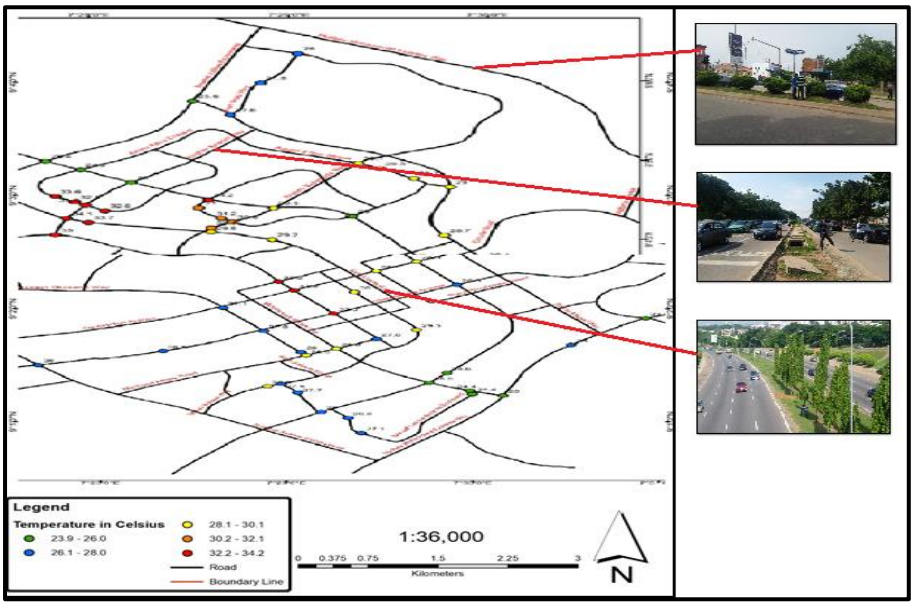

Figure 7. Abuja road corridor temperature distribution survey

6 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusions

That by the year 2050, around 66 per cent of the world's population will be living in cities is no longer strange. But without commensurate planning in place, climate change and the pressures of a growing society could see the costs of managing an overheated city stacking up. Economists from the UK, Mexico and the Netherlands report that around a quarter of the 1,692 cities surveyed could become warmer by as much as 8°C (14.4°F) by 2100, (Li Yang *et al* 2016, and Robert *et al*

2010). As the mercury spikes, so will the economic costs of running an overheated city. On the bright side, green mobility in the form of mass transit electric powered light rail is one of the solutions that Nigeria must key-in. Nigerian roads are littered with out-modelled and out-of-used vehicles. The UHI effect is a phenomenon that causes urban areas to become warmer than the surrounding rural regions, as concrete buildings and roads replace open land and vegetation. This is in consonants with the US Environmental Protection Agency (USEPA) report that, pavement surface temperatures can be as much as 50-90°F (27-50°C) hotter than the surrounding air on a hot summer's day.

Apart from the direct impact on public health, higher-than-average temperatures could also cripple a city economically via civil unrest and reduced productivity due to heat stress and disrupted sleep. This would also be exacerbated by an increased demand for electricity, which would in turn put more stress on a city's power grid, resulting in more frequent or prolonged outages, or a need for a whole new system entirely. This is not unconnected to the government policy on the evacuation of nation grid supply to Abuja at the detriment of other states of the federation.

Recommendations

Based on afore discussions, the following urgent approaches are recommended:

i. The federal government through the Abuja Municipal Council re-visit and renew the overdue Abuja master plan
ii. The federal government should as a matter of urgency seize from her lip-service to the global SDGs and fully implement the overdue Abuja Light Rail that will positively woo the other cities of the federation.
iii. A Pack-and-Ride transport system should accompany the light rail system when implemented.
iv. There should be deliberate attempt to have targeted year of moving the country from fossil fuel dependent automobiles to Eco-friendly ones in consonant with the global crusade on Global Warming and Climate Change Mitigation as in USEPA (2012).

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Water Scarcity Problem and Households' Adaptation Strategies: Evidence from Literature

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Abstract:

Water has been widely acknowledged to be explicitly linked with economic progress and developmental trajectories of most countries and regions of the world. The lack of water supply to household's manifest in different dimensions; physical, access, quantity, quality and affordability. The United Nations Sustainable Development Goal (SDG) 6.4 aspires to significantly reduce the proportion of people suffering from water scarcity by 2030 among other policies. Despite the laudable initiatives and policies, water scarcity has continuously remained one of the most excruciating problems around the globe. This study therefore adopts the review approach to identify, and synthesize from extant literature the dimension of global water scarcity problem, as well as several evidences of strategies employed by households in coping with this pervasive phenomenon. Evidence from extant literature indicates that water scarcity is a lingering global phenomenon as global water availability remained near constant within the last century, with human population continuously increasing in connection to water use and withdrawals. However, the manifestation of water scarcity is far more pronounced in developing countries, as these countries are bound to experience extreme water scarcity in the foreseeable future due to increased water demand as 55% of the global population are said to reside in these countries. In addition, the review showed that households respond to the situation of water scarcity by employing four major strategies (Exit, Voice, Loyalty and Neglect) in adapting to the unreliable and intermittent public water supply. This study therefore suggests the need for policy response in terms of prioritization of interventions and measures to address water scarcity and deprivations.

Keywords*: Coping, Household, Scarcity, Strategies, Water.*

1.0 INTRODUCTION

Water is explicitly linked with economic progress and developmental trajectories of most countries and regions of the world and it has remained a top priority on international agenda as it contributes significantly to quality of life, public health and socio-economic development. Several policy initiatives have been developed over time to address water crisis at the global, regional and country level example of these initiatives are; (United Nations Water for Life Decade 1981-1990; The Dublin Principles of 1991 and UNCED Rio Declaration 1992 on Agenda 21. In recognition of water scarcity as a form of human deprivation, the United Nations Sustainable Development Goal (SDG) 6.4 aspires to significantly reduce the proportion of people suffering from water scarcity by 2030.

Despite these laudable initiatives, water scarcity has continuously remained one of the most excruciating problems around the globe. For instance, between 1.5 and 2.5 billion people in world were estimated to have lived under some degree of water scarcity around the year 2000 (Alcamo et *al*., 2007; Kummu et *al*., 2010; Gosling and Arnell, 2016; Kummu et *al*., 2016), with two-third of the world's population likely to live under water-stressed conditions by the year 2040 (UN-Water and FAO, 2007; Reigh et *al*., 2013; Liu et *al*., 2015).

Against the background of the disproportionate nature of water scarcity over time, coupled with urban population growth dynamics, it is important to assess the extent to which the world, regions,

countries and urban cities are water poor. Therefore, the objective of this current study is in twofold: attempt a review of global water scarcity problem and provide empirical case study evidence of households' adaptive strategies employed against the pervasive menace of water scarcity. This is the focal point of this research.

Water scarcity is a lingering global phenomenon and it represents a condition where the demand for water cannot be fully satisfied due to shortage in fresh water availability (Falkenmark et al., 1989; Vorosmarty et al., 2000; Taylor, 2009). It is often defined within the context of available water resources vis-a-vis human population (Cselenyi, 2013) and as such, refers to an area consisting of a large number of people suffering from water insecurity during a long time period.

Molle and Mollinga (2003) mentioned 5 dimensions of water scarcity:

- *Physical scarcity:* Occurs when water sources are limited by nature.
- *Economic scarcity.* It is the inability or lack of means to provide water needs/use due to limited human or financial resources.
- *Managerial scarcity:* May occur when water systems and infrastructure suffer massive neglect or not properly maintained.
- *Institutional scarcity*: Is an induced scarcity, which depicts a failure on the part of a society to deal with rising supply: demand disequilibrium and preservation of the environment.
- *Political scarcity:* Occurs where people are barred from accessing an available source of water due to political discrimination/ subordination.

The resultant dynamic of rapid population growth and constant water availability implies that water use and consumption is likely to surpass water supply levels in some regions of the world. This observation has been further supported by the International Water Management Institute (IWMI) estimates that around 1.2 billion people globally have limited or no access to safe water and the demand is expected to increase by 40% by 2030. Aside being a global challenge, the characterization of water scarcity also manifest itself severely in developing countries (Jimenez – Cisneros *et al*., 2014) were substantial proportion of the global population reside (Gerland *et al*., 2004). Compared to developed countries, water availability per capita index (1950=100) in developing countries (humid and arid) has been nose-diving, with such decline expected to reach between 15- 25% by year 2025(Watkins, 2006; White, 2012). With 7.9 billion out of 9 billion people projected to live in developing countries by the year 2050 (Ziotnik, 2016), increase in water demand and the lack of water to satisfy the increasingly growing demand will remain severe in developing countries of the world, even in the foreseeable future. In this regard, population growth is expected to directly or otherwise shift about 55% of the world's population towards severe water scarcity over the next generation (Rockstrum, 2011). The problem of water scarcity also shifts the burden of safe and reliable water supply to virtually all households, who consequently engage in a variety of strategies to cope with the lack of access to water supply. As rightly noted by Macheve *et al*. (2015) the estimated cost of coping with lack and unreliable water supplies to Nigerian households is estimated, on average, at US700 million dollars on yearly basis.

2.0 LITERATURE REVIEW

2.1 Theoretical Framework

In spite a growing body of knowledge on water governance (Cleaver and Tonner, 2006; Franks and Cleaver, 2007; Huitema *et al.*, 2009) there is a lack of consensus on a single theory to provide explanations on the nexus between water provision and institutions. This study however hinges on the concepts of adaptive capacity, and the Exit, Voice, Loyalty and Neglect (EVLN) approach to water coping measures.

2.2 The Concepts of Adaptive Capacity

The concept of adaptive capacity provides the analytical framework for the social water stress index (Turton and Ohlsson, 1999; Ohlsson, 2000). The Social Water Stress Index (SWSI) is premised on a country's ability to cope to water shortages given factors as varied as distributional equity, political participation and access to education. Therefore, it is deeply rooted in the concept of natural resources construction. The concept of natural resources construction implies that developing countries tend to overuse their environmental capital, and make a series of conservative, economic and environmental adjustments which would enable such countries to engage in natural resources construction (Allan and Karshenas, 1996). In view of the fact that, increased water scarcity potentially limits economic growth and impedes social stability (Falkenmark, 1994 and 1997) the work of Turton and Olhsson (1999) hypothesized that rising levels of water scarcity will probably result in a series of coping strategies or measures to be implemented by the decision makers. It is these measures that are potential source of conflict and instability in developing countries; as such measures are mainly allocative in nature thereby changing the balance of privilege in the society.

This particular theory is relevant in this study as it provides the analytical framework on the available water resources, increasing level of water scarcity, resulting in the adaptive behaviour by the decision-making elites as to how households employ the necessary coping strategies for the increasing water scarcity so as to yield a better result.

2.3 Conceptual background on aversion/coping against unreliable water supply

The link between inadequacy relating to the dimensions of access to water supply and household coping strategies is often presented in literature as "aversion behaviour" (Abraham et al., 2000; Jakus et al., 2009; Nastiti et al., 2017). In the literature, the concept of aversion behaviour is analogous to that used in behavioural and environmental economics to measure and mitigate economic issues such as damages resulting from environmental externalities. Research on averting behaviour suggests that households tend to implement diverse measures in order to adapt or reduce their exposure to risk and uncertainty resulting from poor water supply (Abraham et al., 2000; Vasquez, 2012; Nastiti et al., 2017). Following Um et al. (2002) analytical framework on averting behaviour, households' adoption of any averting behaviour(s) to unreliable water supply emerges from a two (2) step generic process: First, households form their perceptions of the level of water

services when exposed to unreliable water supply services. Secondly, based on their perceptions, households adopt a variety of averting measures that may reduce the perceived risks.

The representation of the conceptual framework on households' water coping measures is provided in fig 3. As a starting point, to provide its conceptual clarity, the research by Kudat et al. (1993), Humplick et al. (1993) and Madannat and Humplick (1993) represent some of the earliest concepts developed to systematically provide explanations on the unreliability of water supply and its negative impact on households in the three countries of India, Turkey and Pakistan. Based on their conceptual framework, it was posit that water supply to households has the three important attributes of quality, availability in terms of quantity and pressure. The absence of water supply in meeting these three attributes at optimal levels suggests that water supply is unreliable and, households will adopt several adaptive strategies to mitigate the perceived risks from such unreliable water supply system.

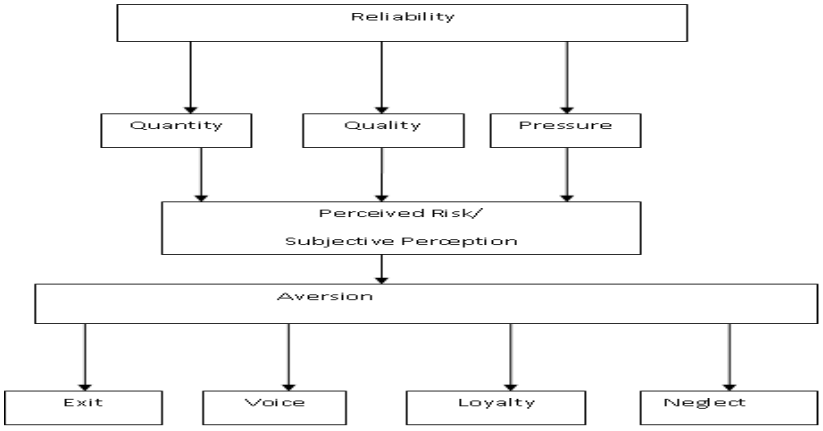

Figure 3: Conceptual framework for aversion and coping strategies

Source: Modified from Nastiti et al. (2017), Um et al. (2012) and Vasquez (2012)

As proposed in the study by Lyions and Lowery (1986), households tend to respond to unreliable and unsatisfactory situations through one or more combination of the four main strategies of *"Exit, Voice, Loyalty and Neglect"* (EVLN concept). The concept initially developed by Hirschmann (1970) surmised that consumers respond to decline or unsatisfactory conditions in firms and organizations through the three (3) *"Exit, Voice and Loyalty* (EVL) strategies. The study by Rusbult et al. (1982) however extended the Hirschmann's EVL model by including *neglect* as a strategy employed in response to dissatisfaction with a situation.

The empirical study by Majuru (2015) on the reliability of water supply in developing countries noted that the *"exit"* strategy entails households exiting or leaving unreliable public water supply by adopting strategies like well drilling, use of capacity storage tanks or relocating to neighbourhoods with good water. The *voice* strategy involves efforts such as protests, dialogues and complaints to water supply authorities which are geared towards reconciliation (Abubakar, 2012; Majuru, 2015). *Loyalty* strategy involves waiting for the poor water supply to improve. Loyal households in such case engaged in accommodative strategies such as rescheduling households' water related activities, collecting water from alternative sources and consuming less

water (Abubakar, 2012; Majuru, 2015). Abubakar (2012) mentioned that the *neglect* strategy entails putting less effort or doing nothing and developing negative attitudes towards the unsatisfactory water supply. The research by Rusbult et al. (1982) however mentioned that there are two dimensions to the EVLN strategies of unreliability in public water supply. While *voice and loyalty* are categorized as constructive response (as they are meant to maintain or revive the subsisting poor water supply), *exit and neglect* are deemed classified as destructive responses as they are not meant to revive the declining water situation).When the EVLN strategies are further examined using an alternative lens, Abubakar (2012) noted that voice and exit strategies are active responses (because something is being done) and loyalty and neglect are passive in nature (as they entails do nothing responses).

2.4 Coping strategies in water scarcity

Against the background that public water services are characterized by unreliable and intermittent supply, prior studies in the literature have provided evidence on the ways urban households cope with this challenge of water scarcity- which poses severe threats to urban livelihood and sustainability. The summary of findings for some of the empirical studies on water scarcity coping strategies identified in the extant literature are presented in Table 1.

From the table above, the study by Baisa et al (2010) for instance, examined the unreliable piped water supply in urban Mexico City using the national household and income survey, and found that storage tank is the most common strategy employed by households in coping with their water supply problem. Similar findings have earlier echoed that water storage within households is a well-established practice for providing reserves of tap water or rain harvest (Gulyani et al., 2005; Caprara et al., 2009). The study by Potter and Darmame (2010) examined the use of piped water from a social equity dimension and showed that high income households adopted larger storage capacity tanks compared to low income households in urban Jordan. Zerah (2000) assessed examined the strategies employed by Delhi households in coping with unreliable water supply in India. The results of a survey of 700 households from 4 residential zones indicated that a substantial proportion of respondents representing 63.10% stored water, while 16.50% drilled boreholes, 11.90% complained and 1.50% intended or changed residence Choe et al. (1998) noted that residents of urban Dehra in India adopted the use of storage tanks, enhancing pressure and improving the water quality as palliative measures against intermittent water supply. Kudat et al. (1997) provided evidence that boiling was the most common water treatment method employed in Urban Baku, Azerbaijan with low income households leaning more towards the adoption of accommodative than enhancement water coping measures. Pasakhala et al. (2013) examined the coping strategies used by 217 households (111 renters and 106 owners) by conducting a household interview and water consumption survey in Kathmandu, Nepal.

Table 1: Coping strategies employed by urban households

S/N	Coping Strategies	Baisa et al (2010)	Caprara et al (2009)	Chaminuka & Nyatsanza (2013)	Cho et al (1996)	Sanusi (2010)	Gerlach & Franceys (2009)	Gullyans et al (2005)	Jamal & Rahman (2012)	Kudat et al (1993)	Kudat & Musayer (1997)	Myco (1996)	Pattanayaka et al (2005)	Potter & Darmae (2010)	Subbaraman et al (2013)	Vasquez et al (2009)	Vasquez (2012)	Vigee & Gaskin (2010)	Zerah (1998, 2000)
1	Installation of storage tanks	X					X	X		X		X	X	X		X	X	X	X
2	Store water in buckets/bottles		X	X			X			X	X		X		X				X
3	Collect water from alternative source			X	X		X		X	X	X		X		X				
4	Drill wells, install hand pump			X		X			X	X	X		X						X
5	Purchase water		X				X		X	X	X	X	X	X		X			
6	Install electric pumps				X		X			X				X					X
7	Treat water(boil, filtrate, chlorine)				X	X			X	X		X	X	X		X		X	X
8	Recycle water									X									X
9	Use water sparingly						X			X					X				
10	Harvest rain water			X		X													
11	Rescheduling activities											X							X
12	Protest or complain						X		X	X	X	X							X
13	Move to another house/area									X									X
14	Install extra storage space									X									
15	Reduce bath/alter diet									X									

Source: Adapted and modified based on Majuru (2015)

Findings from their research showed that water storage tanks and water supply from multiple sources were the predominantly used water coping measures by both renters and owners in the study area. Furthermore, the study concluded that while strategies as varied as water purchase from commercial supply, use of gray water and ground water extraction were employed by both owners and renters, there was significant difference between the two group of households in terms of their adoption of large water storage tank, rainwater harvesting, reduction in water consumption and water efficiency retrofit (efficient shower heads and dual flush toilet system) as coping measures.

Research on the willingness of 420 households to pay more for improved piped water supply in urban areas of Trinidad indicated that capacity tanks, water purchase, water treatment, rescheduling activities and protest to water authorities are the explaining coping strategies (Mycoo, 1996). Similarly, Virjee and Gaskin (2010) examined the willingness to pay for change in the service quality experienced among different categories of 1419 water users (piped in residence, piped in residence and other secondary source and no residence connection) at Trindad and Tobago. In their study, storage tanks and water treatment were identified to be the most important water coping mechanisms employed in Trinidad and Tobago. Jamal and Rahman (2012) examined the coping strategies employed to tackle the water supply crisis in Dhaka, Bangladesh. The study revealed that drilling wells, collection from shared sources, buying water and water treatment were the adaptive measures employed as response to unreliable water supply. In line with the findings in Sanusi (2010), the study also reported that community action as a coping strategy was sought by households through contributing towards the establishment of a tube well.

Chaminuka and Nyatsanza (2013) investigated the cause and extent of water shortage and the coping measures employed by urban residents in Harare, Zimbabwe using convenience sampling. The empirical findings revealed that water collection from boreholes and neighbours, rainwater harvesting during rainy season and drilling of wells were used by the respondents as coping strategies against water shortage. Subbaraman et al (2013) conducted a survey of informal water delivery to 959 households in Kaula Bandar- a non-notified slum in India. The survey results indicated that aside the use of private tanker, 95% of the sampled households resort to the use of less than 50 litre of water per capita per day in periods of water supply failure. Gerlack and Franceys (2009) analyzed the water supply services focusing on poor and vulnerable water users in urban Jordan. The authors reported that the households coping strategies employed were buying of water from private tankers, the use of storage tanks, collection from wells, buying bottled water, scheduling major household activities to when water is available and limiting water use. A specific investigation by Majuru (2015) conducted a systematic review of 1398 studies on coping with water scarcity in developing countries using search criteria such as coping strategies, costs and determinants of coping. The study surmised that three categories of coping strategies can be identified from the review: (1) enhancing and conserving water (2) improving water quality and (3) enhancing water flow rate.

In Nigeria, Adekalu et al. (2002) examined households' water supply system, water use practices and water demand in four cities of Lagos, Ibadan, Ife and Ilesha in southwestern Nigeria. Findings based on the in-depth interview and personal observation of 5000 households showed that only 30% of the respondents have access to public piped water supply, and have

to purchase storage tanks of various capacities for storing tap and rainwater, and invest in alternative water sources such as the construction of both shallow and deep wells as coping strategies for unreliable public water supply. Acey (2008) analyzed the effects of 389 households' responses to public-piped water supply problem in the two urban cities of Lagos and Benin city in Nigeria. The survey result indicated that 40% of the dissatisfied households in Lagos exited, 17% voiced, and 19% showed loyalty and 2% employed neglect. In Benin, 15% exited, 37% voiced and showed loyalty respectively while 1% neglected the water supply problem.

Sanusi (2010) examined the problem of water supply and sanitation facilities in five (5) urban fringe settlements of Minna, Nigeria. Based on a questionnaire survey of 80 households and a focus group interview of four women each in two of the five selected settlements the study showed that the households were water-stressed, and exhibited collective action in managing water sources by making contribution for water facilities repairs. Findings from the study also indicated that digging shallow holes near river valleys during dry seasons, water treatment by boiling and adding alum, purchase of sachet water when water quality becomes unbearable and rainwater harvesting during rainy seasons were the major households' adaptive measures employed across the five fringe urban settlements. The specific study conducted by Ahile et al. (2015) examined the coping strategies of 228 households against water scarcity in Makurdi, Nigeria. Based on their questionnaire survey, the respondents identified dredging dry hand dug wells as the most commonly used coping strategy while minimizing water use was the least employed coping strategy. In the study, fisher's exact test was also employed to examine the level of association between the socio-demographic characteristics of the households and the strategies employed to cope with water scarcity. The study concluded that with the exception of level of education, both place of residence and income level were found to be statistically different from zero at 99% probability level.

3.0 CONCLUSIONS

This study has provided evidence on the extent of global water scarcity and households' strategies employed across countries and at a local scale in coping with water scarcity challenge. evidence from literature indicates that global water availability has remained near constant within the last century, with human demand increasing in connection to water use and withdrawals, and the manifestation of water scarcity to be far more pronounced in developing countries. also, the review of literature showed that households coping measures are varied and highly localized, as there is no clear consensus among the studies regarding the strategies employed by households in adapting to unreliable and intermittent public water supply. This study therefore suggests the need for policy response in terms of prioritization of interventions to address specific water scarcity as well as the need to address and reinvent a more improved means of coping strategies to help reduce the problems of household water scarcity.

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Assessment of the Resilience-related Capabilities of Households in Bida Town, Niger State, Nigeria

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Abstract:
Urban areas are today facing a plethora of socio-economic and environmental problems due to their high population growth rates, densities and congestions, and these have made highly fragile and unstable. There is therefore the need for households, as the basic units of the urban areas, to develop coping mechanisms or shock absorbers in the event of disasters. In view of the foregoing, this study set out to assess household resilience-related capabilities, that is, asset ownership of households in Bida with the view of determining their level of resilience. In order to attain this, a set of questionnaire was administered on 594 household heads in Bida and the data obtained were analysed using the descriptive statistics and linear scaling technique. The outcome of these revealed that while the indices of plots of land (0.597) and building ownership (0.587) lie in the moderately resilient category, the indices of automobile (0.467), livestock (0.474), and appliance ownership (0.483) lie in the low category of capability-based resilience. The study further revealed that Bida recorded a resilience-related capability index score of 0.522. Thus, it is moderately resilient in the assessed variables of capability-based resilience. To this end, the study recommended that efforts should be made in establishing small-scale industries, so that more residents of Bida would be gainfully employed and this would naturally build-up households' asset stock. It was also recommended that households should be encouraged to build some levels of resilience through entrenching the saving culture and increased asset ownership (especially in livestock production).

Keywords: Households, Resilience, Social, Shocks.

INTRODUCTION

Urban areas are today facing a plethora of socio-economic and environmental problems due to their high population growth rates, densities and congestions (Williams, 2000). Owing to these and others, poverty and its associated challenges arefast becoming severe and pervasive urban features (Badiane, 2006). Thus, the United Nations (UN, 2014) stated that poverty is the greatest global challenge facing the world today, and this, in the opinion of Sridhar (2015), has risen with urbanization. As a result of this, Desouza (2014) asserted that the urban environment is becoming highly fragile and unstable. Despite this fragility and instability, the urban environment is still considered as the most important catalyst of human development (Usman, 2019). This is because according to the World Bank (2015), it generates "more than 80% of global Gross Domestic Product (GDP)".

A study by Garschagen (2014) alluded to the fact that urbanization is most often framed as the driver of risk. In other words, there is a nexus between urbanization and vulnerability (exposure to risks). The implication of this is that the urban environment has become susceptible to the vagaries of climate change, pollution, diseases and economic shocks among others. Thus, households, as the basic units of the urban environment would have to develop coping mechanisms or shock absorbers in the event of disasters (Usman, 2019). These mechanisms as stated by Department for International Development (DFID,1999) could be in the form of human, social, natural, physical and financial resources. Morrone*et al.* (2011) on the other hands asserted that the ability of an individual or household to withstand a crisis without significant or long-term losses in wellbeing is, to a large extent, dependent on the assets they can draw upon for support or protection.

The accumulation of assets as encapsulated by McKay (2009) in Etim and Edet (2014) is an important route by which households can move out of poverty, improve their wellbeing and livelihoods, as well as enhancing their resilience. Doss *et al.* (2008) similarly underscored the importance of asset ownership by stating that it is a necessary livelihood capability that can be used as collateral.Edet and Etim (2014) also asserted that asset ownership is an indispensable component of an individual's fall back portion and it as well enhances livelihood protection during emergencies. To this end, the Asian Development Bank (ADB, 2018) submitted that there is a strong positive correlation between asset ownership and long-term wellbeing of individuals and households.

As a result of the importance and indispensability of asset ownership by households, Etim and Edet (2014) opined that in the assessment of poverty and vulnerability levels of households, the use of asset ownership dimension is more dependable and stable than income and expenditure measures. This is because assets are accumulated over a period, thereby giving a clearer dimension of poverty and vulnerability levels (ADB, 2018). Owing to the foregoing, Carter and Barrett (2006) in Etim and Edet (2014) concluded that households that do not own assets are at a risk of being caught in poverty trap. Kraay and McKenzie (2014) described poverty trap as a situation where a household is unable to meet its economic and basic needs. Grant (2010) and Ogwuche (2014) both asserted that there is a spatial dimension to poverty trap. It is therefore possible to have poverty-trapped households, neighbourhoods or communities. In view of this, this study set out to assess the resilience-related capabilities, that is, asset ownership of households in Bida with the view of determining their level of resilience.

RESEARCH METHODOLOGY

This study employed the use of both the primary and secondary sources of data collection. The primary data was obtained through questionnaire administration, and the following indicators of resilience-related capabilities formed its basis - ownership of buildings, cultivable and/or plots of land, household materials/appliances, livestock, and automobile. The secondary data on the other hand was obtained from related research exercises.

Sample Population – According to the Niger State Bureau of Statistics (NSBS, 2012), Bida had a 2006 population census figure of 188,181. Hence, using the 3.2% national population growth rate (NPC, 2016), the 2019 estimated population figure of Bida was 283,408. The estimated figure was based on the following geometric growth formula

$$P_1 = P_0(1 + r)^{\mathrm{n}} \qquad (1)$$

Where: P_0 = the projected population; P_1 = base year population;
r = population growth rate; $^{\mathrm{n}}$ = number of years/interval

Sample Size - This study is premised on assessing the performance of households in the indicators of resilience-related capabilities. But owing to the lack of data on the number of households in the study area, its projected population size was divided by the average household size of Niger State, which according to the Priority of NPC (2006) in Kwara State Bureau of Statistics (2011) is 5.3. The estimated number of households in the study area was therefore 53,473 (see Table 1). The sample size of the study, that is, 594 households(at 4% pre-determined margin of error) was thereafter obtained using Calculator.net (2016) - an online sample size calculator. The questionnaires were thereafter proportionally administered on the 12 neighbourhoods of Bida identified by Usman (2019). Table 1 showed the estimated population figures of the respective neighbourhoods which were calculated based on the 2016 estimates in Usman (2019) as well as their sample sizes.

Table 1: The estimated 2019 population figure and sample sizes of the neighbourhoods

S/No	Clusters	Estimated Population	Estimated No. of Households	Sample Size
1.	Bangaie	29,793	5,621	62
2.	Bangbara	20,599	3,887	43
3.	Banma	39,957	7,539	84
4.	Banwuya	40,576	7,656	85
5.	Banyagi	36,388	6,866	76
6.	Dokodza	29744	5,612	62
7.	Esso	46,251	8,727	97

S/No	Clusters	Estimated Population	Estimated No. of Households	Sample Size
8.	GRA	9,855	1,859	21
9.	Ndazabo	4,421	834	10
10.	Poly Area	14,357	2,709	30
11.	Project Qtrs.	5,300	1,000	11
12.	R. Dangana	6,168	1,164	13
	Bida	283,408	53,473	594

Source: Calculated based on Usman (2019)

Sampling Technique – The multistage sampling technique was employed in the data collection process for this study. The technique was made up of the clustered, stratified and random sampling techniques. But due to the differences in the number of streets as well as the organic nature of the neighbourhoods of Bida, different field protocols were used in the sample selection process for each neighbourhood. In other words, the stratified sampling technique was employed to subdivide each neighbourhood into strata, that is, streets or block of houses where there are no streets. The allotted questionnaires for each neighbourhood were then proportionally shared among the strata. The geographical location of each of the 12 neighbourhoods is shown in Figure 1.

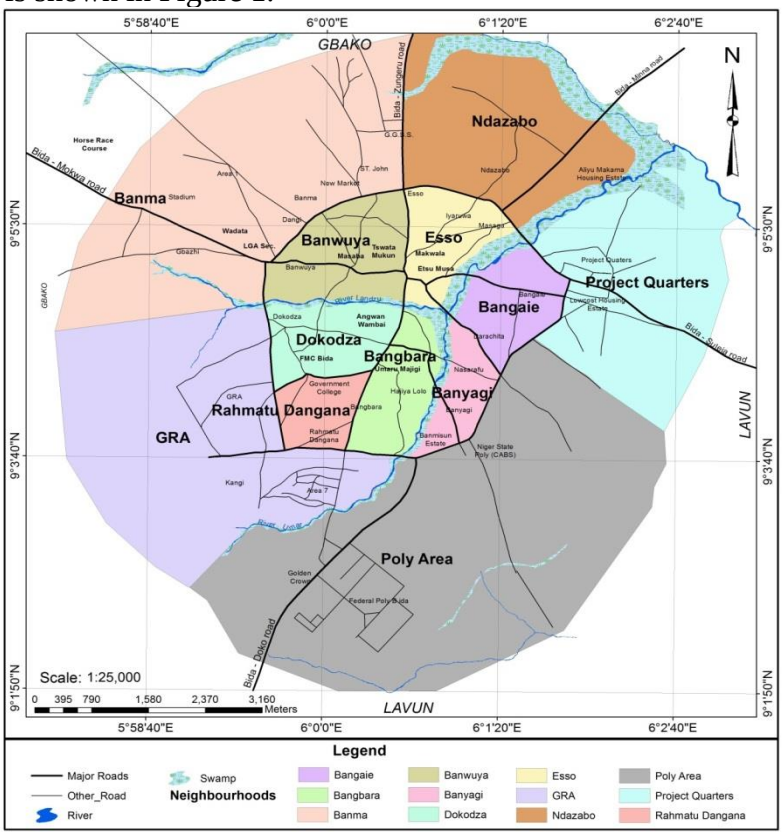

Figure 1: Neighbourhoods in Bida

Source: Usman (2019)

The random sampling technique was subsequently used to select the required samples from each of the strata. The random sample selection was achieved with the use of the raffle draw system. But where the selected sample was a compound house, the random sampling technique was further employed in selecting the sampled household. The data used were collected with the aid of the 'KoBoCollect' data collection tool and the targeted respondent in each household was the household head (or his/her representative).

For the purpose of measuring and analysing the respective indicators of resilience-related capabilities, the descriptive statistics, that is, the frequency and percentage (analysis) techniques were robustly used. In other words, thefrequency and percentage techniques were employed in analysing the responses elicited and retrieved from the structured questionnaires. The analysis was achieved with the aid of Microsoft Excel and the Statistical Package for Social Science (SPSS)- a computer-based statistical analysis tool. The results of these were thereafter discussed and presented in simple graphics analysis (charts and tables). The indicators of resilience-related capabilities were further assessed using the linear scaling technique and the composite of these represented the capability-based resilience index of Bida town. The linear scaling technique formula is expressed below:

$$= \frac{X_j - X_{min}}{X_{max} - X_{min}} 0 \leq \text{variable index} \leq 1 \qquad (2)$$

Where:

X_j = value of the jth variable in the study area;

X_{min} = minimum value of the jth variable;

X_{max} = maximum value of the jth variable.

In order to determine the performance of the study area in the indices of resilience-related capabilities, the classification and index range of capabilities shown in Table 2 was adopted. The classification was adopted and modified from the United Nations Development Programme's (UNDP) categorisation of Human Development Index (HDI). As presented in the Table, an index range of 0.8001-1.000 connotes high level of capability, while an index score of 0.000-0.5000 connotes low level of capability.

Table 2: Classification of Resilience Performances

Class of capabilities	Index range
High	0.801 - 1.000
Medium	0.501 – 0.800
Low	0.000 – 0.500

Sources: adopted and modified from Tutor2u.net (2017) and The Reut Institute (2018).

DATA ANALYSIS AND PRESENTATION

This section analysed the capabilities that enhances the resilience of households, that is, the tangible materials, which could serve as shock absorbers, by restoring households to their pre-shock levels without seriously undermining their well-being.The analysed data on the resilience-related capabilities are presented thus:

The analysed data on the ownership of cultivable and/or plots of land variable as shown in Figure 2 revealed that 59% of the household heads in the study area own plots of land while 41% do not own any. It is discernible from this that the majority of household heads in Bida do have some level of assets they can fall back to in the event of a shock or disaster, thereby enhancing their resilience level.

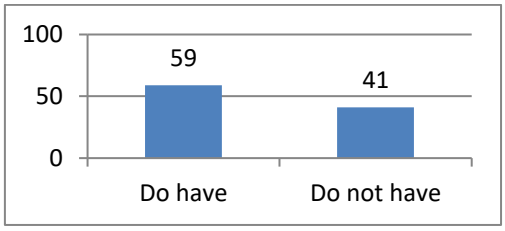

Figure 2: Proportion of cultivable and/or plots of land owned by household heads (%)

The data obtained on the average number of cultivable and/or plots of land owned by households in Bida is analysed in Figure 3. According to the Figure, there is at least a householdin the study area that does not own any plot of land. The Figure also revealed that the maximum number of plots of land owned by a household is 8, while the average number of plot ownership among the households in Bida is 1.3.

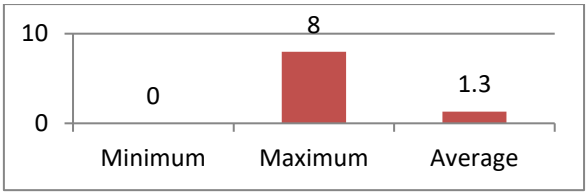

Figure 3: Average number of cultivable and/or plots of land owned by households

Figure 4 presented the analysed data on the proportion of households living in houses owned by the household heads. The Figure showed that 62% of households in Bida reside in houses owned by their heads, whereas 38% of the households do not reside in housesowned by their respective heads. The high percentage of home ownership among the residents of the town is explained by the peculiar nature of the transfer of plots of land or vacant rooms at the urban core. The process involves giving out not too sizable parcel of land or some vacant rooms within the compound to the younger generation. However, the onus of either erecting on the parcel of land or rehabilitating the building, as the case may be, lies on the new owner.

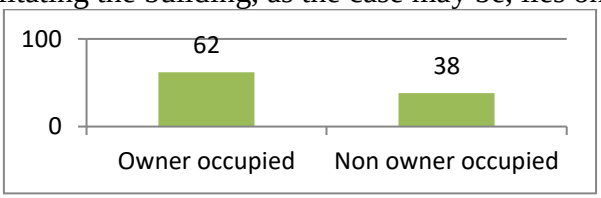

Figure 4: Proportion of households living in houses owned by the household heads (%)

The analysis of the data on the mean number of buildings owned by households is presented in Figure 5. According to the Figure, there is at least a household in Bida that do not own any building, while the maximum number of buildings owned by a household is 5. The Figure also revealed that the mean building ownership value among households is 1.1. This showsthat although not all households in Bida own houses, a good number of them own more than one.

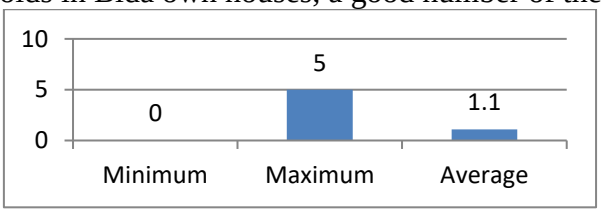

Figure 5: Mean number of buildings owned by household

The household materials assessed in this study are basically made up of electronics or appliances that have some economic value. The ownership of these appliances can and do serve as shock absorbers in the event of financial crisis. Data on these as revealed in Figure 6 showed that 94% and 91% of household heads in Bida own handsets and television sets respectively. The Figure also indicated that 54% and 50% of the household heads own radio sets and satellite dishes respectively. Hence, as presented in the Figure, all the materials assessed contributed significantly to the composite value of the material ownership (66) of households in Bida.

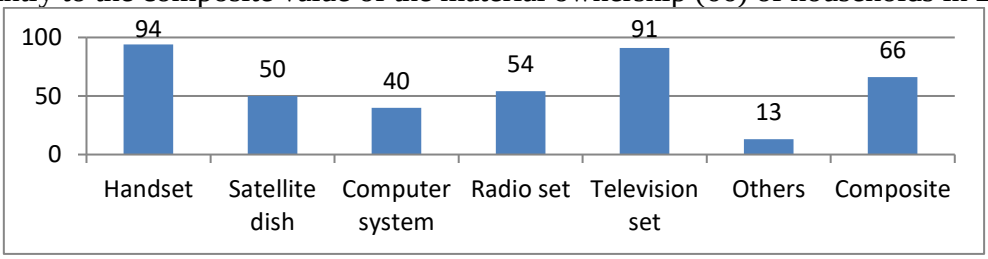

Figure 6: Proportion of household material ownership by household heads (%)

Figure 7on the other hand, presented the data sourced on the mean number of household material ownership in Bida. The data displayed in the Figure indicated that the average number

of handset and television set ownership per household is 2.5 and 1.6 respectively, while the average number of computer system ownership is 0.7. In the same vein, the Figure revealed that the satellite dish and radio set ownership scores per household is 1.3 respectively. By and large, all the assessed items, except computer systems, have mean scores of more than one. Therefore, households can dispose some of these items and still hold on to some in the event of any financial crisis.

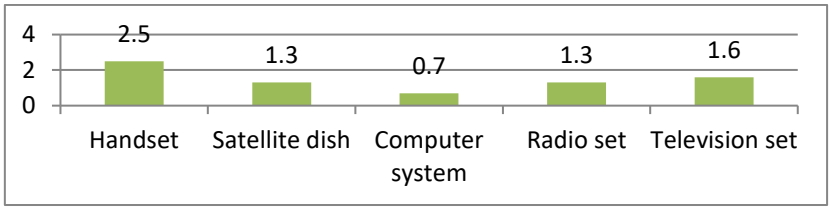

Figure 7: Mean number of material ownership by households

The analysis of the data on livestock ownership among household heads in Bida, as shown in Figure 8 indicated that goats and poultry are respectively owned by 40% and 38% of the household heads. Thus, they are the dominant livestock in terms of proportional contributions to asset ownership in the study area. The Figure also revealed that 13% and 6% of the household heads own sheep and cattle respectively, whereasthe composite score of the livestock assessedis 16.The composite score of livestock was however observed to be comparatively higher in the traditional/core neighbourhoods of the study area. This might be explained by the fact that aside being considered as a resilience building mechanism,animal husbandry or livestock ownership is also believed to be of cultural importance by the people of Bida. It is thus embraced by a high proportion of theindigenes who are the predominant residents of the traditional/coreneighbourhoods of the town.

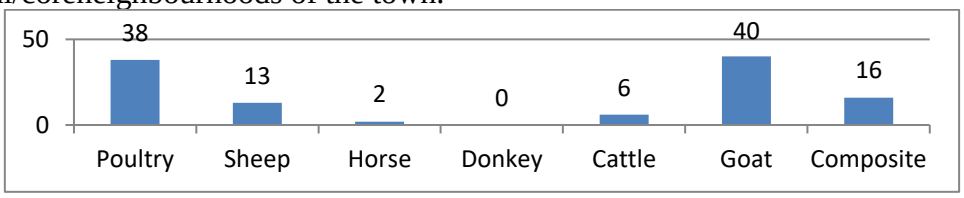

Figure 8: Proportion of livestock ownership by household heads (%)

The data obtained on the mean number of livestock owned by households in the study area is shown in Figure 9. The Figure indicated that poultry had the highest ownership mean value of 15.2/household; it is then followed by cattle and goats with average ownership values of 5.9 and 5.5 respectively. The Figure also revealed that the mean numbers of horses and sheep per household in the study area were 1.1 and 5.2 respectively. It is discernible from the foregoing that households have built resilience around livestock ownership; thereby cashing-in on the sale of these animals, and also make brisk business during festive seasons when the prices of the animals would have soared up. These, in the opinion of the household heads, have helped them in one way or the other to solve some problems that have confronted them.

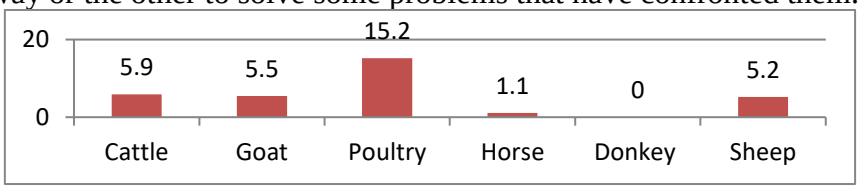

Figure 9: Mean numbers of household livestock ownership

Automobiles play important roles in the movement of goods and services. Hence, they enhance the living standards of households and communities. This is aside the fact that they can be sold whenever the need arises. Data on the proportion of automobile ownership among household heads as reflected in Figure 10showed that the household heads in Bida own a range of

automobiles. A look at the Figure indicated that cars (36%) and motorcycles (68%) are the widely owned automobiles in the study area. The Figure similarly revealed that 8% and 2% of household heads own bicycles and buses respectively. The composite value of this variable, as shown in the Figure is 23.

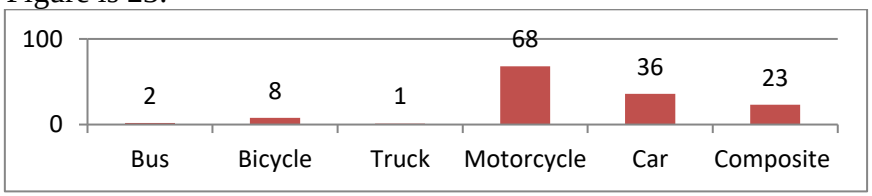

Figure 10: Proportion of automobile ownership by household heads (%)

Figure 11 presented the data on the average number of automobiles owned by households in Bida. As presented in the Figure, the average number of motorcycles owned per household is 1.8, while that of cars and bicycles are 1.3 and 1.2 respectively. The Figure also revealed that the household mean ownership of trucks and buses are 0.3 and 0.0 respectively. Hence, motorcycles and cars are the automobiles with the highest mean number of ownership by households in the study area.

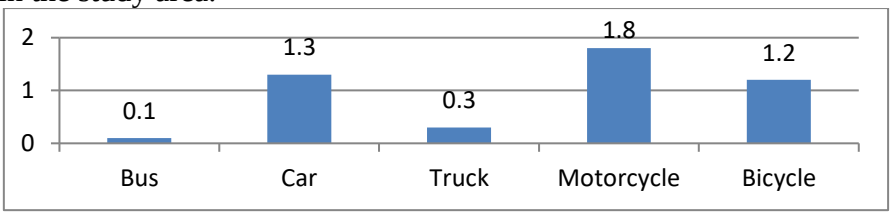

Figure 11: Mean number of household automobile ownership

The capability-based household resilienceindex of the study area was thereafter calculated with the aid of the linear scaling technique. The calculation was based on the ownership or otherwise of the earlier assessed household assets, using their percentage scores or composite values. According to the analysis of this as shown in Table 3, the actual (percentage) score of plots of land ownership is 59, while that of building ownership is 62. Similarly, the Table indicated that the composite score of appliance ownership is 66, whereas those of livestock and automobile are 16 and 23 respectively.

The outcome of the calculation as shown in Table 3 revealed that while the indices of plots of land (0.597) and building ownership (0.587) lie in the moderately resilient category, the indices of automobile (0.467), livestock (0.474), and appliances ownership (0.483) lie in the low category of capability-based resilience. A critical look at the Table also indicated that the best performance (index score) was recorded in the building ownership variable, while the study area recorded an index score of 0.522 in the assessed indicator. Thus, Bida is moderately resilient in the indicators of capability-based resilience.

Table 3: Assessment of the Capability-based Resilience Indicator (%)

Variables	Actual score	Maximum observation	Minimum observation	Observed performance	Remarks
Plot of lands	59	90	13	0.597	Moderate
Buildings	62	81	35	0.587	Moderate
Materials/Appliances	66	81	52	0.483	Low
Livestock	16	26	7	0.474	Moderate
Automobile	23	31	16	0.467	Low
Average scores				0.522	Moderate

CONCLUSION AND RECOMMENDATIONS

The outcome of this study has shown that household heads in Bida own a wide range of resilience-based capabilities. Although the ownership index of these capabilities lie either in

the low or moderate category, the mean number of some of the assessed variables per household was above 1.0. This was evident in the mean number of poultry (15.2), and handsets (2.5) ownership per household. Other assets than recorded mean value of more 1.0 were motorcycles (1.8), as well as plots of land and cars, with each recording a mean score of 1.3 respectively. The implication of these is that households have to some extent, built some levels of resilience through asset ownership and would probably transit from a non-preferred situation to prosperity easier, in the event of a shock or disaster. As a way of further improving the present state of affairs in the study area, the following recommendations have been put forward:

i. Efforts should be made in establishing small-scale industries, especially in areas where Bida has comparative advantage, such as agriculture and artworks (glass and brass work). By so doing, more residents of Bida would be gainfully employed and this would naturally build-up households' asset stock.
ii. Households should be encouraged and sensitised on the need to build some levels of resilience through entrenching the saving culture and increased asset ownership (especially in livestock production).

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Appraisal of Households' Resilience to Social Shocks in Bida Town, Niger State, Nigeria

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Abstract:
The resilience of households, as the basic units of the society, is one of the most important precursors for the attainment of social resilience by a society. This is because the lack of household resilience makes communities highly insecure and delicate by exposing them to the debilitating effects of poverty (financial shocks), insecurity, youth restiveness and violence. Social shocks are inevitable but can be checkmated by the ability of households and communities to cope with and adjust to social threats. To this end, this paper assessed the preparedness of households in Bida town to shocks that may result from their social conditions. In order to attain this, a set of questionnaires was each administered on a total of 594 household heads (or their representatives) using a multistage sampling technique. The data collected were analysed using the descriptive statistics. The outcome of this indicated a high rate of income poverty in Bida. The study also revealed that households in Bida are challenged by the low and moderate levels of social safety nets and community connectivity indices respectively, and these have resulted in their poor social resilience. Hence, the study area has become susceptible to high rates of poverty (financial shocks) and poor community stability. Owing to these, the study recommended that NGOs and CBOs should make efforts at taking the large number of poor households in Bida out of poverty through developing their productive skills in agriculture, arts and crafts. It was also recommended that the NGOs and CBOs should also be encouraged to embark on resilience building activities such as mobilising members of the community to undertake self-help projects, serving as a voice for all, and helping in public enlightenment/information dissemination.

Keywords: Households, Resilience, Social, Shocks.

INTRODUCTION

Households, as social entities and the most basic units of the society, need to build resilience in order to ensure the wellbeing of their members. This is because aside the availability and efficiency of the necessary public infrastructure and services, a resilient household is the most important precursor for the attainment of resilience threshold by a society (Usman, 2019). Resilience, in the opinion of the World Bank and Australian AID (2012) could be in the form of social, economic, institutional, infrastructure or community plan. The development of social resilience mechanisms by a household as encapsulated by Cacioppo *et al.* (2011) basically entails its ability to anticipate, prepare for, withstand and bounce back from shock(s) through the utilisation of interpersonal and collective resources and capacities. This according to Bird (2007), can also be achieved through bringing income and consumption back to pre-shock levels within a given time period, without seriously compromising the household's wellbeing or moving it into non-preferred or adverse forms of coping.

In the opinion Jones (2015), the purpose of embracing resilience-building activities by households is to deal more effectively with the challenges of climate extremes, financial shocks and other risk factors that threaten lives and livelihoods. This is because the social consequences of these phenomena on households are dire, and they include psychological imbalance, breeding and exacerbation of poverty and diseases, and sub-optimal human capital development (Kreimer, 2001). A fallout from the lack of resilience indicated that there were 700 identified disasters worldwide in the year 2001, resulting in 25,000 deaths, $11.5 billion in insured losses and $36 billion in economic losses (Munich ReGroup in Godschalk, 2003). The UN-Habitat (2012) on the other hand stated that the economic losses incurred as a result

of urban disasters worldwide in the year 2011 were over $380 billion. These in the opinion of Usman (2019) have the propensity of plunging and consolidating the poverty level of households and by extension that of communities, through eroding their capabilities.

Social resilience according to Keck and Sakdapolrak (2013) is engendered on three dimensions – coping, adaptive and transformative capacities. Hence, households and communities that lack these capacities tend to perform poorly when shocks or disasters strike. Agrilinks.org (2018) also asserted that assets, capacities and risk factors have been identified as fundamental and complementary pathways in-and-out of poverty in the event of a shock. Poverty is, therefore, one of the end results of shocks and it also affects resilience because it predisposes household members to social and economic crises, especially when they possess limited resources (Usman, 2019). Poverty is also, as emphasised by the United Nations (UN, 2014), unarguably the most potent cause of social and environmental challenges today, and it at the same time, poses some serious health risks to the population. Consequently, the susceptibility of households to poverty, diseases, insecurity, political thuggery and youth restiveness, in the opinion of Sanders *et al.,* (2008) straddle acute and chronic conditions.

The ability of households to checkmate and/or mitigate these acute and chronic conditions depends on their capabilities, assets and activities (Alinovi *et al.*, 2010). Therefore, the capabilities of households in their livelihood approaches determine their level of resilience. Moore (2005) in Bird (2007) listed a wide range of household livelihood approaches affected by poverty, and they include financial, material and environmental capital; human capital; and social, cultural, and political capital. In view of the foregoing, Diwakar and Shepherd (2018) conceptualise resilience as the capacities of households to remain out of poverty in the long term, even in the face of shocks and stresses owing to their capabilities.

In a study conducted on some 46 rural women in Burkina Faso by Gash and Gray (2015), one of the women was reported to have defined a resilient household as one that is able to find solutions to the various crises it encounters by making good choices in their income-generating (and social) activities. It is discernible from the aforementioned that income and strong social ties are important components of household resilience building mechanisms. While the former supports live and livelihoods, the latter sustains positive relationships in order to endure and recover from life stresses and social isolation (Abesamis *et al.*, 2006). To this end, this research exercise appraised the preparedness of households in Bida town to shocks that may result from their social conditions.

RESEARCH METHODOLOGY

For the purpose of this research exercise, both the primary and secondary sources of data collection were employed. The primary data were collected through the use of a set of questionnaires, and the variables obtained were households' monthly incomes as well as the following indicators of social resilience - social safety nets and community connectivity. On the other hand, the secondary data used, included information reeled out by other authors/researchers on related issues and the population figure of Bida town.

Sample Population - The 2006 population size of Bida, according to the National Population Commission (NPC) in Niger State Bureau of Statistics (2012) was 188,181. Therefore, using the 3.2% national population growth rate (NPC, 2016), the projected 2019 population size of Bida was 283,408. The projected population figure was calculated using the geometric growth formula. The formula is expressed in equation 1:

$$P_1 = P_0 (1 + r)^n \qquad (1)$$

Where: P_0 = the projected population; P_1 = base year population;

r = population growth rate; ^{n} = number of years/interval

Sample Size - This study is household-based and the targeted respondent in each household was the household head (or his/her representative). The number of households in the study area was obtained by dividing its population by 5.3, which is the average household size of Niger State (see the Priority of NPC, 2006 in Kwara State Bureau of Statistics, 2011). The estimated number of households was, therefore, 53,473. Furthermore, the Calculator.net (2016) - an online sample size calculator - was used to obtain the sample size of the study from the population of the study area. Consequently, a sample size of 594 households was obtained, at 4% pre-determined margin of error, and the questionnaires were proportionally administered on the 12 neighbourhoods of Bida (as delineated by Usman, 2019). The estimated 2019 population figures of the respective neighbourhoods (calculated based on the 2016 estimated figures in Usman, 2019) as well as their sample sizes are shown in Table 1.

Table 1: The estimated 2019 population figure and sample sizes of the neighbourhoods

S/No	Clusters	Estimated Population	Estimated No. of Households	Sample Size
1.	Bangaie	29,793	5,621	62
2.	Bangbara	20,599	3,887	43
3.	Banma	39,957	7,539	84
4.	Banwuya	40,576	7,656	85
5.	Banyagi	36,388	6,866	76
6.	Dokodza	29744	5,612	62
7.	Esso	46,251	8,727	97
8.	GRA	9,855	1,859	21
9.	Ndazabo	4,421	834	10
10.	Poly Area	14,357	2,709	30
11.	Project Qtrs	5,300	1,000	11
12.	R. Dangana	6,168	1,164	13
	Bida	283,408	53,473	594

Source: Calculated based on Usman (2019)

Sampling Technique - As a way of drawing samples for the study, a multistage sampling technique of questionnaire administration was employed. This technique was made up of the clustered, stratified and random sampling techniques. Under this method of sample selection, each of the 12 neighbourhoods of Bida was considered as a cluster. Figure 1 shows the spatial location of these clusters/neighbourhoods.

Different field protocols were however adopted in the sample selection process for each neighbourhood due to the differences in the number of houses, streets and the organic nature of most of the neighbourhoods (especially those at the core area). The stratified sampling technique was thereafter employed in subdividing each neighbourhood into strata; the allotted number of questionnaires for each neighbourhood was then proportionally shared among the strata (streets or block of houses where there are no streets).

The random sampling technique was then used in selecting the required samples from each of the strata. The random sample selection was achieved with the use of the raffle draw system. But where a compound house was selected as sample, the random sampling technique was further employed in selecting the sampled household. The 'KoBoCollect' data collection tool (a mobile digital data collection application used on Android, iOS, and many other devices) was used in the questionnaire administration exercise.

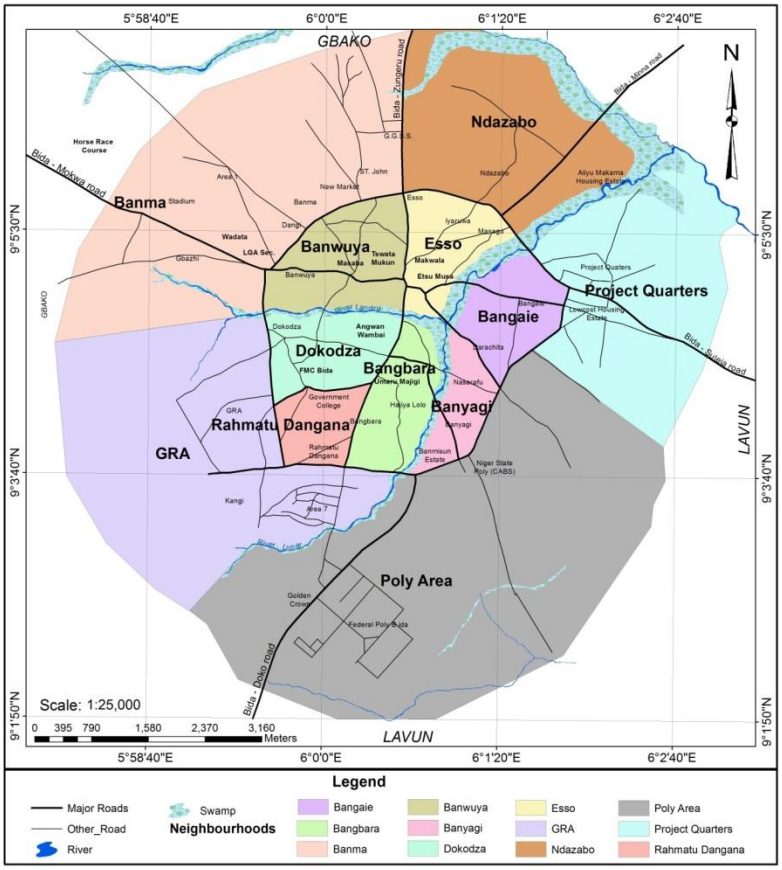

Figure 1: Neighbourhoods in Bida

Source: Usman (2019)

Methods of Data Analysis - The data obtained from this exercise were basically analysed using the descriptive statistics - frequency and percentage (analysis) techniques. In other words, the descriptive statistics was employed in measuring and analysing the income and social resilience levels of the study area. The analysis was achieved with the aid of Microsoft Excel and the Statistical Package for Social Science (SPSS) - a computer-based statistical analysis tool. The results were thereafter presented in simple graphics analysis (charts). However, in order to determine the performance of the study area in the indices of income and social resilience, the United Nations Development Programme's (UNDP) classification of Human Development Index (HDI) as reflected in Table 2 was adopted. In addition, a range of index scores was also provided; hence, an index score of 0.000-0.500 entailed low income/resilience while a score of between 0.801 and 1.000 entailed high income/resilience.

Table 2: Classification of income/resilience

Class of poverty	Index range
High	0.801 - 1.000
Medium	0.501 – 0.800
Low	0.000 – 0.500

Sources: adopted and modified from Tutor2u.net (2017) and The Reut Institute (2018).

Household poverty measurement - The income poverty (headcount ratio) of the study area was measured using households' total monthly income. The indicators used were the UN's $1.90/day/person poverty line, the mean as well as the median incomes of the study area. In order to obtain the Naira equivalent of the UN's $1.90 poverty line, the American Dollar-Naira

exchange rate of ₦360.00 as at October, 2019 was used. Hence, the equivalent of $1.90 was ₦684.00. The household poverty line of Bida was consequently derived by multiplying ₦684.00 by the product of 30 (that is, the average number of days in a month) and 7.8 (the average household size of Bida - established by this study). In the same vein, the mean and median monthly incomes derived by this study are ₦95,441.00 and ₦60,000.00 respectively.

Household Social Resilience Assessment – The questionnaire for this assessment was developed with the aid of the Likert scale of measurement technique, and each of the indicators of social resilience was measured using its respective variables. Hence, the questionnaire was close-ended; that is, options (responses) and their respective weighted scores were provided under each variable. Under this technique of resilience measurement, options for each of the variables were weighted in the multiples of five, starting from zero in an ascending order, that is, from the least to the most resilient option. The index scores of the respective indicators were obtained by multiplying the frequency score of each option by its weighted score. The outcome of this for each variable under an indicator were summed up and divided by the product of the sample size and the maximum obtainable weight for the indicator. This method of resilience assessment was used in Usman (2019) and the formula in equation 2:

$$\textit{Resilience Index (R. I.)} = \frac{a_1 + a_2 + a_3 \ldots + a_n}{SS \times MOW} \quad (2)$$

Where:

a_n= frequency score of variable n, multiplied by the weight of variable n (the average value in case of the study area);

SS = number of samples for each neighbourhood (the average number of samples in case of the study area);

MOW = Maximum obtainable weight of an indicator by a household.

DATA ANALYSIS AND PRESENTATION

Income poverty measurement

Data on the headcount ratio, as shown in Table 3 revealed that 87.0% of the households in Bida live below the UN poverty threshold of $1.90/capita/day. However, 43.7% and 65.7% of the households respectively live below the median and mean incomes of the study area. The Naira equivalent of the UN poverty line at household level in Bida is ₦160,056.00, while the monthly median and mean incomes of households are ₦60,000.00 and ₦95,441.00 respectively. The Table also showed that using the composite of the three poverty lines, the poverty incidence of Bida is 65.5%. The poverty index of the study area showed moderate performance in median income, but was observed to be low in the mean and UN poverty thresholds respectively. The poverty index was also observed to be low in the composite of the respective poverty lines used in this study.

Table 3: Households' headcount ratio

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	Median income	Mean income	UN's poverty line	Composite
Remark	Moderate	Low	Low	Low

Social Safety Nets of Households

Humans as social beings interact and leverage on their social ties in order to sometimes, make ends meet. Hence, they benefit from one another, and this could be in the form of financial and/or material assistance. The purpose of which is to enhance their living standards through

poverty alleviation and resilience building. In view of these, this section sought to determine, whether or not, individuals and households have benefitted from their social ties, and the variables studied are: assistance from local organisation(s), assistance from personal networks and assistance from international organisations. The issues are presented thus:

Local organisations such as Community Based Organisations (CBOs) and Non-Governmental Organisations (NGOs) play some critical roles in human development as well as in resilience building through the services they render. However, 78% of the households in Bida as reflected in Figure 2 opined that they do not benefit from the outreach programmes of these organisations as against the 22% of households that stated that they do. In the view of the households, there are quite a number of NGOs and CBOs in Bida, but most of them are politically motivated and render assistance based on political patronage. This therefore, is an indication that the existing NGOs and CBOs have not effectively covered the needs of the residents of Bida.

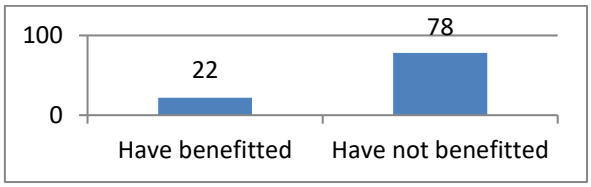

Figure 2: Assistance from Local Organisations (%)

Bida town, owing to its ancestral and cultural heritage is supposed to have strong ties of kith and kin, where households are expected to leverage on their social capital. But this, on the account of the data presented in Figure 3, is obviously not the case. Thus, the analysed data on the assistance from the personal network variable indicated that 35% of the respondents stated that they do not receive any assistance from personal networks such as friends and associates, while 65% of the households said they do. However, all the respondents opined that most members of their households do in one way or the other contribute to the prosperity of their respective households.

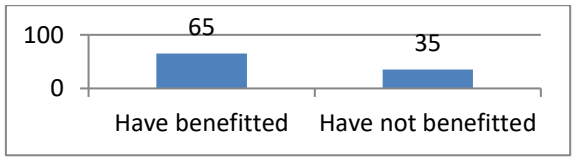

Figure 3: Assistance from a Personal Network (%)

The data collected on the proportion of households that have received assistance from international organisations is presented in Figure 4. The Figure revealed that only 4% of the households in Bida have at one time or the other received assistance from international organisations. On the contrary, 96% of the households stated that they had never received assistance from any international organisation.

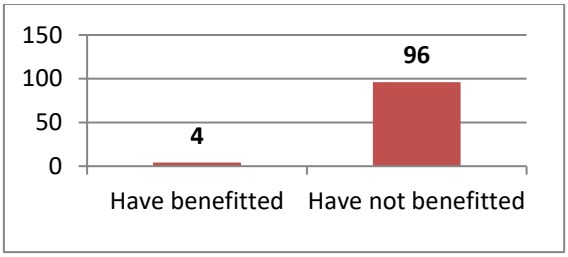

Figure 4: Assistance from International Organisations (%)

Among the reasons advanced by the households for not accessing assistance from international organisations is the lack of awareness or publicity of the activities of these international organisations and the stringent conditions attached to some of their facilities such as loans and grants.

The data obtained from the measurement of the variables of social safety net index in Bida are presented in Table 4. The variables as well as the keys used in their measurement are as follows:

O – Ever received assistance from any local organisation?

P - Ever received assistance from a personal network?

I - Ever received assistance from any international organisation?

The social safety net index measurement was calculated thus:

$$\text{Resilience index} = \frac{58 + 170 + 12}{49.5 \times 15} = 0.323$$

Table 4: Measurement of Social Safety Nets Index

	O	P	I	Index	Remarks
Bida town	58	170	12	0.323	Low

The analysis of the data presented in Table 4 revealed that the study area recorded an index score of 0.324. The implication of this is that it lies in the low resilience category of the social safety net index.

Community Connectivity of Households

The psychological satisfaction of humans within their immediate environment is considered necessary and indispensable in resilience building. This is because if education, the freedom to interact and associate are not accorded and guaranteed, the resilience level of individuals, households and neighbourhoods will be seriously undermined, thus making them susceptible to shocks and disasters. Hence, data addressing these concerns were collected under this indicator, the purpose of which was to assess the level of connection between households in Bida with their social environment. The following variables were used in this regard: educational qualification of household heads, community stability and availability of places of social gatherings.

Data on the educational qualification attained thus far by household heads in Bida is presented in Figure 5. The analysed data presented in the Figure indicated that 6% of the household heads do not have any certification in formal education, whereas 15% and 3% have the Senior Secondary School Certificates and the Primary School Leaving Certificates respectively. The Figure on the other hand, showed that 10% of the household heads in Bida have post graduate certificates, 25% are graduates, and 24% have either HND or NCE certificates. This goes to show that the literacy level among household heads in Bida is 91%. This is because the basic education level in Nigeria is the JSSCE (Junior Secondary School Certificate of Examination), and any educational qualification below it depicts illiteracy. As a result of this, only 9% of household heads in Bida (made up of 3% with primary school certificates and 6% with no formal education), are non-literate.

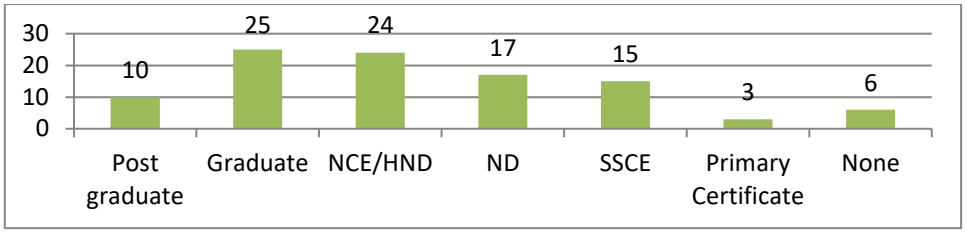

Figure 5: Educational qualification of household heads (%)

Figure 6 presented data on community stability in Bida. The data indicated that there was a mixed opinion of almost equal proportion among household heads as regards the issue of community stability. The Figure revealed that 52% of the household heads in Bida opined that their neighbourhoods are stable in terms of peace and security, while 48% stated that their neighbourhoods are not. The differences of opinion between household heads are as a result of the fact that parts of Bida town have, for sometimes been ravaged by the menace of youth restiveness, political thuggery and violence. The residents of such neighbourhoods are therefore living in perpetual fear of harassment and intimidation, and this could undermine their wellbeing. The implication of this is that the conventional policing system in Bida has not been able to arrest the many security challenges facing it.

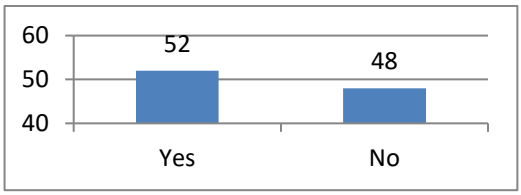

Figure 6: Community Stability (%)

Places of social gatherings/relaxation spots are necessary for the development of man socially and otherwise. The analysed data on this variable shown in Figure 7 revealed that parks (*chambas*) with 47% and viewing centres/cinemas with 44% are the most preferred places of social gatherings/relaxation centres among household heads in Bida. The Figure also showed that sport centres (1%) and event centres (8%) are not as popular among the household heads. It is discernible from this that, household heads in the study area, and by extension, household members make out time to socialise with their peers and colleagues.

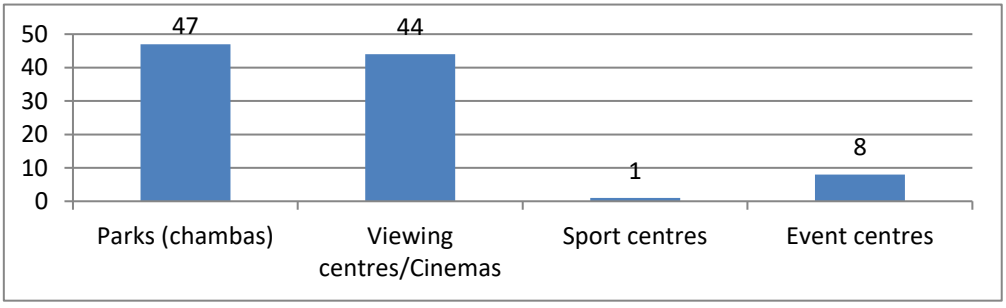

Figure 7: Availability of places of social gatherings

The variables assessed in this dimension are denoted thus: 'E' for educational qualification of household heads; 'C' for community stability; and 'S' for places of social gatherings. The data derived from the measurement of the variables are presented in Table 5. The community connectivity index in the study area was obtained thus:

$$\text{Resilience index} = \frac{183 + 126 + 241}{49.5 \times 15} = 0.741$$

Table 5: Measurement of Community Connectivity Index

	E	C	S	Index	Remarks
Bida town	183	126	241	0.741	Moderate

The analysis of the index score revealed that the study area has a comparatively better index in this dimension. This is because the community connectivity index score of Bida is 0.741, which makes it moderately resilient in this indicator.

CONCLUSION AND RECOMMENDATIONS

The outcome of this study has shown that the headcount ratio of households using the UN's $1.90 daily per capita income poverty line is 87%, while that of the mean and median poverty thresholds are respectively 65.7% and 43.7%. Similarly, the composite score of the aforementioned poverty lines is 65.5%. The implication of these is that most households are living beneath the respective poverty lines assessed (except in the case of the median income poverty line).

The outcome also indicated that households in Bida are challenged by the problem of poor social resilience owing to the low and moderate levels of their social safety nets and community connectivity indices respectively. As a result, the study area has become susceptible to high rates of poverty (financial shocks) and poor community stability (youth restiveness, insecurity, political thuggery and violence). To this end, the following recommendations have been put forward in order to improve the income and social resilience levels of households in Bida -

i. NGOs and CBOs should make efforts at taking the large number of poor households in Bida out of poverty through developing their productive skills in ventures such as agriculture, arts and crafts.
ii. The NGOs and CBOs should also be encouraged to embark on resilience building activities such as mobilising members of the community to undertake self-help projects, serving as a voice for all, and helping in public enlightenment/information dissemination.
iii. Efforts should be made at ensuring stability of the community through the floating of neighbourhood watch (security) outfits.
iv. Governments, NGOs and CBOs should also encourage and sensitise households on the need to adopt some resilience mechanisms such as strengthening of social ties and building of social capital. This, it is believed, would improve the capacities of individuals and households to absorb and respond to shocks more easily.

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A Review of Sustainable Energy Conservation for Residential Buildings

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Abstract:
Scholars have emphasized the need for residential buildings as spaces for rest attain maximum comfort. In attaining such comfort, using sustainable energy strategies is significant. The United Nations (UN) has acknowledged this by establishing affordable and clean energy, sustainable cities and communities as some of its sustainable development goals. Similarly, different studies have expressed diverse views towards attaining sustainable energy solutions in residential buildings across the globe. It is to be noted that sustainable energy solutions in residential buildings are dynamic and contextual. This study therefore investigated the current strategies for sustainable energy conservation in residential buildings across the global landscape using the semi systematic review method. Data was collected through desk study which involved the exploration of academic research repository using the key terms: sustainable energy, residential building, clean energy and renewable energy. The findings of the research showed that several strategies have been established as solutions towards sustainable energy conservation in residential buildings However, Nigeria is yet to explore the application of the sustainable strategies that are suitable. In conclusion the paper suggests suitable solutions and how they can be implemented in residential buildings to achieve sustainable energy conservation in Nigeria.
Keywords: Energy conservation, Residential buildings, Sustainability, Renewable energy, Green energy.

BACKGROUND

Energy conservation is reducing energy consumption by using less of an energy service (Ramya 2015). According to the organization for economic cooperation and development (OECD) (2015), by 2030, if the current trends in the world are not changed, the world's energy consumption will increase by 53% and 80% of the energy will be produced by fossil fuels which will increase CO_2 emissions by 53%.

In Nigeria only 45% of the population has access to electricity (index-mundi, 2018) which is the main source of energy consumption in residential buildings, during the buildings useful phase. This energy is generated majorly with fossil fuels (80%) while the other 20% is through hydroelectricity. However, this 45% of the population, make up the faction that consumes the most energy in the county as seen in Figure 1, the residential sector of Nigeria has the highest amount of energy consumed. This energy consumed by the residential sector is relatively high compared to some other nations as seen in figure 2, irrespective of the amount of the amount of megawatts generated by the country yearly if the current trend continues, the residential sector will always be the largest consumer of that energy in Nigeria.

If the number of houses that has access to electricity is increased, and the source of electricity is not diversified to more renewable sources, it is safe to assume that the energy consumed and CO2 produced will have a lasting degrading effect on the atmosphere and at large the country. It is therefore necessary to come up with sustainable practices to ensure a comfortable life for the current and future generations.

The aim of this research is to establish best strategies for energy conservation in residential buildings.

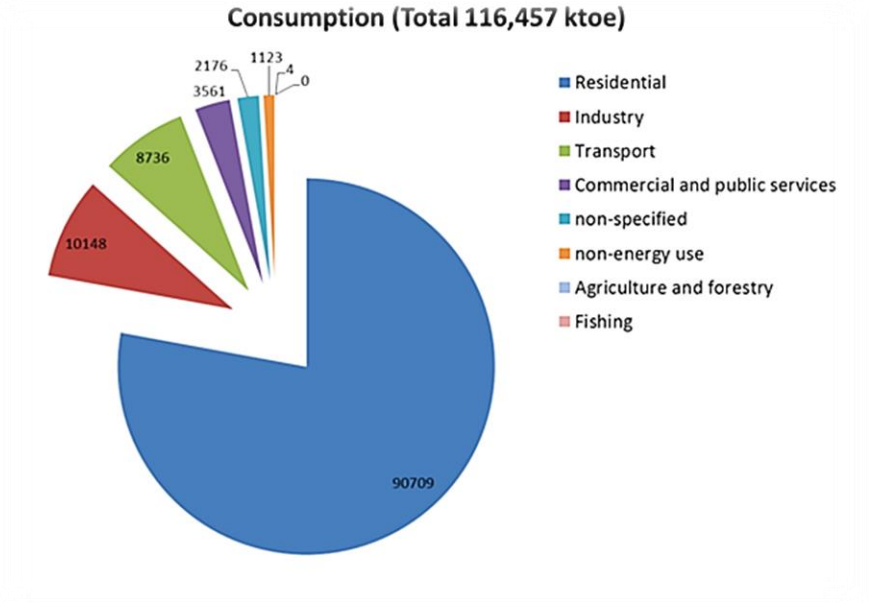

Figure 1: Pie chart showing the rate of Energy consumption in Nigeria, Source: energypedia 2012

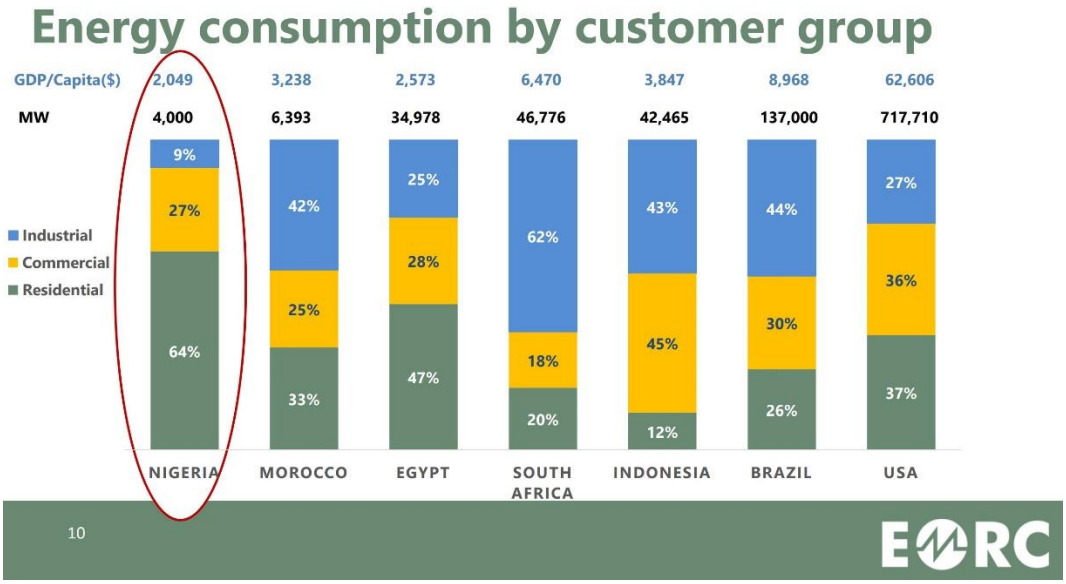

Figure 2: Chart showing the rate ratio of energy consumption in Nigeria and other countries Source: EMRC Nigeria

Energy conservation practices for residential buildings

Ogini *et al*. (2017) proposed contemporary design options to improve the thermal comfort of buildings. They believe that if buildings are made to fit their environment less amount of energy will be used and there will be adequate thermal comfort. Some of the design options they suggested include creation of microclimate, proper lighting, proper ventilation and using shading devices. They believe that it is possible to have buildings without artificial means of cooling and heating. They however did not make consideration for all types of weather and climate, and no solution to already existing buildings was suggested.

The chief function of a building is to provide a comfortable indoor environment to the occupants (Garima, 2016). He believes the focus of energy conservation practices is to optimize the energy performance of a building while reducing dependence on energy guzzling devices

without compromising the comfort of the inhabitants. He also states that the amount and energy used in a building depend mainly on three factors: Quality of life of inhabitants, Climate and Nature of building use. Unlike Ogini *et al*. (2017) he analyzed the different energy use in different seasons, providing necessary data that could be used to propose a balanced design that is functional in all seasons. He, however, did not come up with solutions to already existing buildings and does not share the same belief with Ogini *et al*. (2017)that secondary sources of heating and cooling could be eliminated completely, he believes their use can be reduced, reducing the amount of energy used.

Akande (2015) states that the availability and the use of energy in buildings is pivotal to the building's functionality but if the energy use in buildings is not regulated, it can steadily lead to costly waste to the building users and more importantly to continuous release of CO2 into the atmosphere leading to global rising temperatures and climate change. Unlike Ogini (2017) and Garima (2016), he believes already existing buildings can be retrofitted to conform to current sustainable trends and practices and also improve the indoor comfort of the users. He did not take into consideration the lifecycle of the buildings but only focused on the energy consumed during the middle phase of the building.

Ganahao (2015) recognizes the fact that the building lifecycle is to be considered when establishing sustainable practices to aid energy conservation. He believes the amount of energy used depends on the standard of living of the occupants of the building, people who desire more thermal comfort use more energy services. He believes assessment tools should be used to determine the possible amount of energy a building will use before it is constructed. However, he did not propose possible solutions for the whole life cycle of the building but only the middle phase.

The level of energy provided determines the amount of energy used (Okerieimoh, 2019). A lower amount of energy will have to be used in large amounts and since energy is essential for daily living if it is produced in small quantities large amounts of it will have to be used to achieve the end goal. He believes that energy efficiency does not eliminate the use of energy but it's a process where energy is used in a manner that will minimize the amount of energy needed for services. He believes that there are 2 ways to ensure energy efficiency, technological approach which involves the change of obsolete technology to a more efficient one, and behavioral approach which involves a change in the manner of doing things. He believes that one of the major ways energy can be reduced in Nigerian residential buildings is through the use of energy efficient bulbs instead of the usual incandescent 'yellow bulb'.

Previous researchers have established and recommended the following variables to be considered for studies on energy conservation in residential buildings. The variables were used to analyze literature to determine the best energy conservation practices that should be adopted.

1. Climate: the climate of the area where the building is located determines the amount of energy that will be used for heating or cooling. (Akande 2015)
2. Building use: the nature of activities carried out in the building and their duration determine energy use. (Garima 2016).
3. Quality of life of inhabitants (standard of living): people with a higher standard of living tend to have more need for energy. (Garima 2016).
4. Contemporary design options: orientation, zoning and other factors considered during the design stage of buildings affect their energy use. (Ogini *et al*. 2017)
5. Building lifecycle: the amount of energy expended from inception to demolition. (Ganahao 2015)

6. Amount of energy supplied and used: the lower the energy, the more of it that is required. The type of energy supply is also one of the factors to be considered. (Okerieimoh 2019).
7. Nature of equipment's/additional facilities: the amount of equipment's in the building and their energy consumption rates. (Garima 2016)

METHODOLOGY

Semi systematic review method was used. It is a type of qualitative research method which is used for topics that have been conceptualized differently and studied by various groups of researchers within diverse disciplines (Wong et al 2013). it is applied when it is impossible to review all relevant material concerning a subject and it often looks at how research within a selected field has progressed over time or how a topic has developed across research traditions. In general, it seeks to identify and understand all potentially relevant research traditions that have implications for the studied topic and to synthesize these using meta-narratives instead of by measuring effect size (Snyder 2019). This method was used because of the focus of this research, which involves a study of previously established principles for energy conservation in residential buildings and to postulate the best strategies amongst the numerous proposed.

Survey research design was used in this research, it is a form of research where data is collected from samples to make inferences about a population, and it is used to study attitudes and opinions. Longitudinal survey design was used, it is used to collect data over a long period of time. The Trend studies aspect of longitudinal survey research design was focused on, which involves identifying a population and observing changes within that population over a period. This was used because the focus of this research involves an in-depth study of literature over a wide period. (Creswell 2012).

When applying semi systematic review method, researchers streamline their study to the area of interest in question and observe the theories postulated overtime about it and this serves as their study area (Snyder 2019). Therefore, the study area of this research was energy conservation in residential buildings as the researchers aim was to analyze various theories by several authors in that field. Convenience sampling was used to select a suitable subset of data to be analyzed, because of its ability to select relevant data from a wide range of ideas and this research required precise data gathering from a large selection. Literature were chosen based on the necessary criteria to fit the established study area, Energy conservation practices, sustainable energy & residential buildings were used as criteria in the selection of articles from literature.

Observation schedule was used for this research because of the research design that was adopted, which requires an observation of trends of the various established variables. Primary Data was collected from Academic research repositories based on the developed variables using the observation schedule developed by the researcher. The data was organized using appropriate codes that were assigned to each variable that was identified in the literature review. The organized data was analyzed manually via content analysis which involves a researcher quantifying and analyzing the meaning of words or text and making inferences from it (CSU 2004), This method was used because content analysis is a commonly used technique and can be broadly defined as a method for identifying, analysing, and reporting patterns in the form of themes within a text (Braun & Clarke 2006).

RESULTS AND DISCUSSION

After the data was analyzed the following results were obtained:

Number of resources used = 50

Number of entries of recommendations =64
Number of single recommendations by authors = 35
Number of multiple recommendations by authors = 14
As shown in Table 1, from the 64 recommendations gotten from previous researches majority of the researchers proposed contemporary design options and regulation of the amount of energy supplied and used as strategies to be adopted to achieve energy conservation in residential buildings. This however does not exclude the other variables established.

Table 1: Observed Measures for energy conservation

VARIABLES	CODE	NUMBER OBSERVED
Quality of life	QL	0
Climate	C	9
Building use	BL	0
Contemporary design option	CDO	30
Building lifecycle	BL	3
Energy supplied and used	E	20
Nature of equipment's/additional facilities	EQ	2

Climate

Designing with the climate of a region aids in establishing buildings that are best suited to the environment however they cannot be used as a universal standard, the use of local building materials and natural landscape features also aids in creating sustainable environments. Further analysis of climatic recommendations by authors can be seen in Table 2.

Table 2: Implicit climate data

RECOMMENDATIONS	INTERPRETATION
Use of energy efficient materials	This aids in developing resilient buildings for harsh climate zones
Regular audit of buildings	This aids in observing the reaction to buildings to various weather conditions
Developing and implementing energy building codes	This gives laid down rules to be followed to ensure efficiency of buildings in various climatic conditions
Heat storage and time lag should be minimal	Buildings should be constructed in ways that they give off excess heat to the environment, especially in hot and dry climates
Materials should be permeable to air to provide protection from precipitation	Building materials should be able to allow air efficiently pass through in order to aid thermal comfort and prevent stale air in buildings.
Passive cooling	This is used majorly in hot climatic conditions to aid the indoor comfort of buildings for its occupants
Trees and vegetation at strategic locations	Landscape features shouldn't be installed half hazardly but should be precisely located to ensure shading and protection from harsh climate
Thermal modernization of outer walls	The exterior walls of the building bear the pressure of the climate of the environment and should be fortified i.e. made permeable or air/water resistant depending on the nature of climate
Passive solar techniques	This applies to cold climatic conditions, ways to absorb and trap heat in buildings like insulation should be adopted
Well insulated design	This applies to cold climatic conditions that require compact design with no air leaks
Use of phase change materials	Materials that change based on the nature of the exterior weather condition make designing with the climate less tedious as the weather of an environment changes based on times and seasons
Use of local standard materials	This aids in design as materials found locally have already through the process of evolution adapted to effectively suit the environment

Building Life cycle

Designing with building lifecycle ensures that the whole process from inception to demolition is sustainable, it ensures that the overall cost of the building over a long time is sustainable, although the initial cost of this process may be much.

Table 3: implicit building lifecycle data

RECOMMENDATIONS	INTERPRETATION
Cost effective design options to achieve minimum life cycle cost	The entire life cycle of a building (from preliminaries to demolition) should be simulated and the most cost effective path chosen, this will aid in the reuse of energy and highlight various ways to conserve energy in buildings apart from during its active period of use
Use of green construction to reduce the negative impact on the environment	Green construction ensures that all materials and methods used in the construction of buildings are sustainable
Building condition assessment	The assessment of buildings intermittently help to observe the changes in the energy conservation of buildings as years pass and aid in preparing effectively for future buildings

Contemporary Design Options

The use of contemporary design options have gone a long way in aiding sustainable design as they have evolved overtime with the changes in Architecture and design.

Table 4: contemporary design options implicit data

RECOMMENDATIONS	INTERPRETATION
Use of passive and active systems	This helps create a balance and efficiency, it also involves the use of mixed mode design I.e. the use of both mechanical and natural means of ventilation
Developing and adopting energy use index	The amount of energy used should be monitored effectively
Use of local building materials	Local materials help regulate the building temperature effectively
Contemporary design elements	Design elements like shading and over hangs should be incorporated
Use of appropriate colours	Light or dark colours should be used to trap or release heat from buildings
Proper orientation of buildings	Buildings should be placed effectively on site to maximize the sun direction, slope, wind direction etc.
Proper ventilation	The use and placements of windows is important in maintaining indoor comfort of buildings
Use of shading devices	Shading devices prevent solar glare and heat gain
Proper lighting	Lighting reduces the dependence of mechanical means of lighting and thus reduces the amount of energy consumed
Creation of micro climate	The creation of a sustainable micro climate around the building envelope ensures the buildings efficiency regardless of the prevailing weather conditions
Preventing infiltration	Buildings should be air tight
Insulation	Buildings should be insulated to prevent loss of energy
Use of computer programs	Smart buildings should be proposed to measure levels of energy consumed, indoor comfort and other relevant data

Nature of Equipment

The nature of equipment used buildings must be energy efficient, thus, obsolete equipment's must be updated overtime.

Table 5: nature of equipment implicit data

RECOMMENDATION	INTERPRETATION
Efficiency of electromechanical systems	All equipment's used in buildings should be energy efficient to prevent the overuse of energy
Higher efficiency systems	The systems used in the design and construction of buildings should be the best established by constant improvement and recommendations

Amount of Energy supplied

The amount of energy supplied has to be sufficient in order to prevent demand for more. This will need to be monitored and regulated by governing bodies.

Table 5: amount of energy implicit data

RECOMMENDATION	INTERPRETATION
Tracking energy usage through software	This enables facilities managers and architects to detect how energy is used in buildings and propose counter measures effectively suited
User behaviour modelling for optimization of energy consumption	Simulations of buildings models help to see the amount of energy proposed buildings will likely consume
Building energy simulation programs	Simulations of buildings models help to see the amount of energy proposed buildings will likely consume
Renewable energy sources	Renewable energy makes sure the source of energy is always available and ensures the continuous production of energy
Use of light colour paints	Light paints allow light and heat to bounce off, therefore they do not trap energy
Use of LED bulbs	These have been proven to be better than incandescent or filament bulbs
Sealing doors and windows	This ensures lack of waste of artificial heating or cooling and prevents more amount of energy to be used
Implementation of adequate energy codes	Established building codes should be strictly followed for efficiency
Thermal insulation of the building envelope	Insulation of the whole building envelope prevents air leeks and optimizes the production of energy by artificial means
Managing heat flows by architectural design	Architects should design buildings such that they aid the flow of air within the building
Zero energy buildings	This ensures the use of minimal energy in buildings and creates self-sustaining facilities
Energy-efficient equipment's	All equipment's used in buildings should be efficient to prevent over use of energy
Installation of smart meters	These help monitor building performance

CONCLUSIONS

From the research it is evident that the decisions taken during the design and construction phase of buildings affects the overall performance of the building throughout its lifecycle, it is evidently easier to design energy conservative buildings from inception than it is to retrofit existing buildings to be more energy conservative, as such great care and detail should be taken when designing buildings. The type of energy supplied and the equipment's installed should also be noted as the quality of life of occupants does not have a direct effect on the energy used if all the right principles are implemented

Multiple methods can be used to ensure energy efficiency, however the most widely adopted are contemporary design options which gives specific details on several parts of the building and designing with climate. This can be achieved with standardized building codes for different localities as general building regulations are not a viable means to ensure conservation of energy. However, buildings should also be designed with the end goal in mind, all or most of the building should be recyclable or reusable after its lifecycle has expired.

It is also clear that the residential sector in Nigeria is the greatest consumer of energy in the country, and these numbers are steadily growing as more people and communities get access to electricity. The implementation of energy conservation strategies not only ensures the reduction in energy usage for individuals but also if sustainable strategies are established and implemented, Nigeria as a whole will become more sustainable and in the long run have healthier neighborhoods. The establishment of sustainable strategies must be thoroughly

thought out and an adequate combination of suitable and effective strategies will be most useful. Each strategy has several subsets that can be varied to fit different regions ad this should be the optimum approach, rather than having a general strategy for the whole country.

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Assessment of an Integrating Design Approach of Passive Cooling Principles in Hotels in Minna, Nigeria

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ABSTRACT

Over the years, hospitality has thrived on the high side of energy demand and consumption; accounting for up to 20% to 50% of global energy consumption. In Nigeria, the cost of energy has generally shot up astronomically to a frightening position which mandates the need for sustainable buildings that yield efficient energy conservation through passive means. In order to achieve thermal comfort in hotels in Northern Nigeria where the average temperature is considerably high for most parts of the year, it is vital for the building envelope to reduce heat gain to keep the indoor air temperature lower than outdoor temperature; hence, the need for passive cooling building design approach. This study aims at assessing the passive cooling design techniques in hotels within Minna, Nigeria. The study adopts a rather descriptive research method with the use of purposefully and well-structured observation schedules to assess attendant level of integration of passive cooling principles in the design of hotels in Minna, Nigeria. The findings which were presented using tables, pictures and charts show a low level of implementation and use of passive cooling principles in the design of hotels within the study area. Architects, and other professionals in the built industry should incorporate passive cooling features in hotel buildings as an inherent part of the design; which is a recommendation this paper puts forward. This paper concludes by advocating for the compliance of passive cooling principles in the design and construction of hotels in Minna, and generally in Nigeria to further preach the global gospel of energy conservation and sustainability.

Keywords: *Energy, Hotel, Passive Cooling, Sustainability, Thermal Comfort.*

INTRODUCTION

Over the years, developing countries have witnessed critical problems of energy crisis as a result of rapid increase in cooling requirements of building most especially during the hot periods of the year. Due to the high demand for improved quality standard of living, the energy consumption in buildings is on the rise, and this factor threatens the very existence of the both the environments and its habitats (Hilton Team, 2015). The rapid advancement in technology has brought about mechanized innovations such as air conditioners that have being duly employed in the building sector to cool the indoor environment. The use of this mechanized equipment to cool the building has contributed significantly to the energy consumption of building and in turn, this has contributed to the greenhouse gas emission in the environment. According to the International Energy Agency (IEA), buildings consume about 40% of the world's energy production. Building energy use also produces 33% of all annual carbon dioxide emissions, significantly contributing to the climate changes brought about by the accumulation of this heat-trapping gas (IEA, 2013).

In a bid to achieve thermal comfort in buildings, heating and cooling systems in buildings results into a high level of energy consumption. As the standard of living increases, the level of energy demands also increases and with it is the cost of making it available (Lewis, 2004). Buildings such as offices, schools, hotels, and other public buildings as well as residences most often make use of conditioning plants and are installed almost without proper adaptation of the buildings to these new appliances. This leads to excessive energy consumption and high cost of maintenance, and may also have negative impact on the building life span (Lauber, 2005).

Lewis (2004) identified that as a result of massive energy consumption levels incurred by cooling systems especially in the tropics, members of the built environments have ventured into researching into other passive means of thermal control in order to achieve thermal

comfort. One of such passive means of thermal control is passive cooling, which is the central focus of this paper.

Passive cooling deals with the processes of heat dissipation that occurs naturally, that is without the use of any mechanical components or systems (Bodach *et al.,* 2016). Passive design is also about seeing that the whole building fabric and spaces within responds excellently well and effectively to local climatic and site conditions so as to maximize the comfort level of the occupants of the building. In Hotel and hospitality facilities designs within North-Central Nigeria, the use of passive cooling design techniques has been speculated by earlier researchers as a means to foster thermal control and achieve thermal comfort (Ibrahim, 2017).

Therefore, this paper aims at assessing of passive cooling design techniques in hotels in Minna, for the purpose of creating a sustainable environment. The assessment of design elements for Heat Prevention/Reduction, Thermal Moderation and Heat Dissipation serve as objectives employed in this research work in achieving the earlier stated aim.

LITERATURE REVIEW

An overview of a hotel

A hotel is often a full service lodging facility which is intended primarily for tourists and vacationers. It is a place used for vacation, relaxation or as a daytime getaway (Parpairi, 2017).

Thermal comfort

Thermal comfort can be described as the state of the mind which expresses satisfaction with the thermal environment and is also assessed by subjective evaluation means. This feeling of satisfaction is achieved as the heat released by the human metabolism is allowed to dissipate, which in turn helps to maintain the thermal balance of the surrounding (Jonesa *et al*., 2017).One major design factor that must constantly be in mind through all the design stages of a building is the means of achieving a building which will be thermally comfortable for the occupants.

Thermal comfort in hotels

Since the accommodation industry majorly constitutes one of the largest sectors of the travel and tourism industry. According to Jonesa *et al* (2017), observations reveal that the hotel industry ranks as one of the most energy-intensive subsector of the tourism industry, with about 50% of the energy consumption due to space conditioning.

Passive means of thermal control in hotels in Minna, Niger State.

Minna, the capital of Niger State in Nigeria, popularly called the Power State experiences a typical tropical continental climate with distinct seasonal regimes, oscillating between cool to dry and humid to wet. These two seasons reflect the influence of tropical continental air masses (Ibrahim, 2017).

This study aims to investigate possible techniques that may be used to integrate passive strategies in the cooling design of buildings in the city taking into consideration the high humidity during summer.

Passive cooling

Passive cooling in buildings includes the utilization of normal procedures to accomplish balanced indoor conditions. Chan & Mackenzie (2013) outlined that maintaining a comfortable

surrounding within a space relies on decreasing the amount of heat gains into the space and the removal of excess heat from the space. Passive cooling in a public building covers every single characteristic procedure and systems for cooling structures. It is the cooling without any form of energy intake, other than sustainable energy source. Passive cooling techniques are al·so closely connected to the thermal comfort of the occupants.

It is additionally maximised to expand the effectiveness of sustainable cooling with mechanically helped heat exchange methods, which upgrade the normal cooling procedures. Such applications are called "hybrid "cooling system (Mohamed, 2017). Vitality utilization is kept up at low levels; however the effectiveness of the frameworks and their application is extraordinarily moved forward. In order to cool a building through passive means, the architect needs to have sufficient knowledge of the behaviour of heat in a building.

Passive cooling preventive techniques

Protection from or prevention of heat gains encompasses all the design techniques that minimizes the impact of solar heat gains through the building's envelope and of internal heat gains that is gene rated inside the building due occupancy and equipment. According to Krestiniti (2017), passive cooling techniques includes the following design techniques:

i. Heat prevention/reduction, (Reduce heat gains)
ii. Thermal moderation (Modify heat gains) and
iii. Heat dissipation (Removal internal heat)

Solar and heat protection techniques (Reduce heat gains)

A building must be adapted to its climatic region and its microclimate. It is very important to minimize the internal gains of a building in order to improve the effectiveness of passive cooling techniques. The site design is affected by financial contemplations, zoning regulations and nearby advancements, all of which can meddle with the configuration of a building, as to the episode sun based radiation and the accessible wind. Vegetation can bring about wonderful outside spaces, as well as enhance the microclimate around a building and lessen the cooling burden. Sunlight based control is the essential configuration measure for heat gain protection. The utilization of different shading devices to keep the constriction of the episode sun based radiation from going into the building is discussed by Kapiki (2010).

Microclimate

Climate is the average of the atmospheric condition over a long period of time over a large region. Climate of a place may differ from the climate of the environment areas, due to the distinctive sorts of exercises performed by the occupants in the different areas. The use of fitting arranging components, for example, *vegetation* and *water elements* can adjust the microclimatic state of a range.

The primary stage in controlling higher future inside temperatures in structures is to attempt however much as could reasonably be expected to make the outer air as cool as would be prudent. Within the built surroundings this involves enhancing the infrastructure of trees, open spaces, parks, water features and open water (Chong & Ricaurte, 2014). Rooftop gardens, green walls and green roofs can also be used in a building for its cooling effect.

Solar control

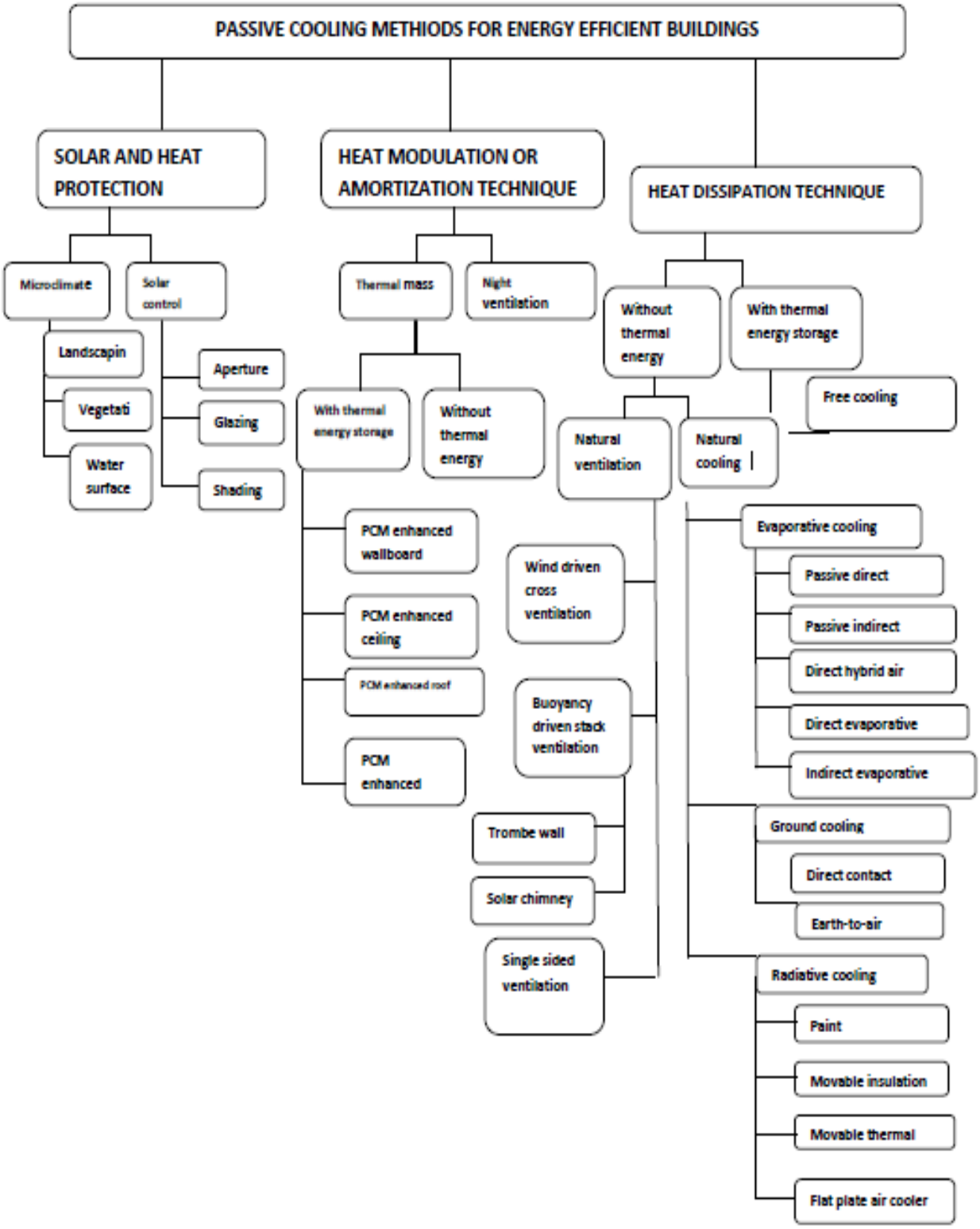

Figure 1: *Classification of passive cooling methods in energy efficient structures.*
Source:*Krestiniti (2017)*

Solar radiation reaches the external surface of a structure in direct, reflected and diffuse for.ms and penetrates to the interior through transparent elements such as glass. The admission of solar radiation into an interior space may cause discomfort, such as high indoor temperatures, visual and thermal discomfort to the occupants, harm to touchy articles and decorations (Gu *et al.*, 2014). Therefore, it is very important that solar radiation should be controlled by paying apt attention the *Aperture, sun shading devices* and *Glazing* used for openings.

Heat modulation or amortization techniques (Modifying heat gains)

Upadhyay *et al* (2017) outlined that the heat control of a building could be accomplished by two routines. In the first system the warm mass of a building (components built of materials with high warmth limit) retains warmth amid the day and controls the measure of indoor temperature swings, lessens top cooling load and exchanges a piece of the consumed warmth to the inside of the building in the night hours. The left over cooling energy can then be covered by natural cooling techniques. In the second method of the vacant structure is pre-cooled during the night by night ventilation which stores coolness and then transfers the coolest into building in the early hour following day, therefore reducing energy consumption for cooling by about 21% (Gonzalez & Yousif, 2015).

Heat dissipation technique (Remove internal heat)

The avoidance and modulation of heat gains cannot maintain indoor temperatures at a control level. A more cooling strategy at an advanced level includes heat removal to heat sinks, such as the upper atmosphere and the ambient sky, by the natural processes of heat transfer (Wang *et al.*, 2015). The design of a structure is a very important factor which affects the cooling potential of a natural cooling technique. Natural cooling refers to the use of natural heat sinks for excess heat dissipation from interior spaces, includes natural ventilation, evaporative cooling, radiative cooling and ground cooling.

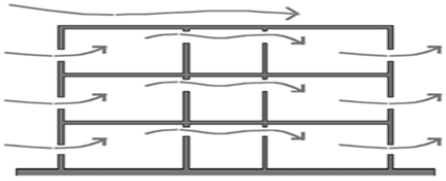

Figure 2: *Concept of wind-driven cross ventilation system.*

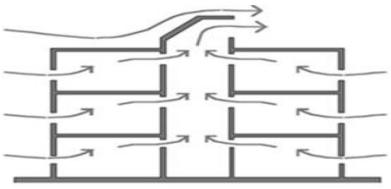

Figure 3: *Concept of buoyancy driven stack ventilation system.*

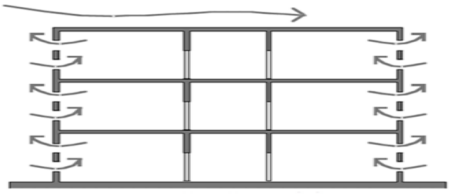

Figure 4: *Concept of single-sided ventilation system.*
Source: *Kapiki (2010)*

RESEARCH METHOD

The research employed a rather descriptive method of research highlighting investigations into the 'what' rather than the 'why' of the subject matter being studied. This paper engaged the use of purposefully and well-structured observation schedules to obtain relevant data for the study, as it relates to relevant knowledge obtained from literature (Palinkas & Soydan, 2012). A sample of hotels in Minna, Niger State was selected and used for the study. Purposive Sampling was used for the selection of samples, as selection was done based on hotels in Minna

that were most suited for assessing design elements for passive cooling and also accessibility due to the security-sensitive nature of certain hotels. The variables observed in the samples taken were targeted towards assessing design features that cater for the following;*Heat prevention/reduction, (Reduce heat gains), Thermal moderation (Modify heat gains) and Heat dissipation (Removal internal heat).*

RESULTS AND DISCUSSION

The results obtained from the observation schedule were documented using tables as shown below:

From **Table 1,** results show that 30% of hotels sampled made use of indoor plants and also trees and shrubs as sun shading devices. Also, 20% of the sampled hotels met an estimated green cover area range of 25-30%. None of the sampled hotels featured green roofs or green walls and 40% had their buildings along the North-South direction. These results obtained reveal low level of integration of climate and natural design measures both in the design of buildings and planning of site, thereby minimizing heat prevention or reduction and reduction of heat gains within the sampled hotels.

Table1: *Assessment of passive cooling features that aid heat prevention/reduction*

S/N	HOTELS	Use of Indoor plants	Use of trees /shrubs for sun shading	25-30% site green cover area	Green walls/ green roofs	North-south building orientation
1	Doko	X	□	□	X	□
2	Dogon Koli	X	X	X	X	□
3	Saftec	X	X	X	X	X
4	Yanna	X	X	X	X	X
5	Falana Suites	□	□	X	X	X
6	Princess az-zahra lodge	X	X	□	X	X
7	Master class l	□	X	X	X	X
8	Yayi	X	X	X	X	□
9	Mairuwa	X	X	X	X	X
10	Mar Haban	□	□	X	X	□
	Total (%)	30	30	20	0	40

□*– Available X – Not available.* ***Source:*** *Authors*

Table 2: *Assessment of passive cooling features that aid heat prevention/reduction*

S/N	HOTELS	Opening-Wall ratio of 35%-45%	Use of reflective/ tinted glass	Water bodies	≥ 6m Distance between buildings on site
1	Doko	□	□	X	X
2	Dogon Koli	X	□	X	□
3	Saftec	X	□	X	□
4	Yanna	□	□	X	X
5	Falana Suites	□	□	X	X
6	Princess az-zahra lodge	X	□	□	□
7	Master class	□	□	X	□
8	Yayi	X	□	X	□
9	Mairuwa	□	□	X	X
10	Mar Haban	X	□	X	X
	Total (%)	50	100	10	50

□*– Available X – Not available.*

Source: *Authors*

Table 2 revealed that**,** only 10% of the sampled hotels had water bodies which help with evaporative cooling, 100% of the hotel buildings featured tinted glass and reflective glass for glazing along openings (which is good for heat reduction) and 50% of the sampled hotels

featured opening-wall ratios of 35-45% and 50% also had minimum distances between buildings on site of about 6m.

Furthermore, **Table 3** shows that none of the hotels within the sample employed Phase Change enhanced Materials (PCM) for walls, roofs and ceilings; thereby decreasing tendencies for the buildings to function effectively for thermal moderation (modifying heat gains).

Table 3: *Assessment of passive cooling features that aid thermal moderation*

S/N	HOTELS	PCM enhanced wallboard	PCM enhanced ceiling	PCM enhanced roofs
1	Doko	X	X	X
2	Dogon Koli	X	X	X
3	Saftec	X	X	X
4	Yanna	X	X	X
5	Falana Suites	X	X	X
6	Princess az-zahra lodge	X	X	X
7	Master class	X	X	X
8	Yayi	X	X	X
9	Mairuwa	X	X	X
10	Mar Haban	X	X	X
	Total (%)	0	0	0

□ *– Available X – Not available.*

Source: *Authors*

Also, from **Table 4,** it is apparent that none of the hotel buildings featured high level windows in rooms and heat insulating materials for wall construction. In addition, only 40% of the hotels featured nature based courtyard or atriums and then, all the hotels were seen to employ bright colours for interior finishes in rooms which is really good for heat dissipation.

Table 4: *Assessment of passive cooling features that aid heat dissipation*

S/N	HOTELS	High level windows in rooms	Nature based atriums/courtyards	Bright Colours for interiors	Heat insulating wall materials
1	Doko	X	□	□	X
2	Dogon Koli	X	□	□	X
3	Saftec	X	X	□	X
4	Yanna	X	X	□	X
5	Falana Suites	X	X	□	X
6	Princess az-zahra lodge	X	□	□	X
7	Master class	X	X	□	X
8	Yayi Hotels	X	X	□	X
9	Mairuwa	X	X	□	X
10	Mar Haban	X	□	□	X
	Total (%)	0	40	100	0

□ *– Available X – Not available.*

Source: *Authors*

Figure 5: *Façade of Princess Az-Zahra lodge*

Figure 6: *Single room at Master Class hotels*

Figure 7: *Courtyard at Doko hotels*

Figure 8: *showing distance between buildings in Mairuwa hotels*

Figure 9: *Façade ofSaftec hotels*

Source: *Authors field work (2020)*

CONCLUSIONS

Results obtained from the study reveal that although certain natural and vegetative elements were featured in the sampled hotels, they were not sufficient as to functioning as adequate sun-shading, evaporative cooling, air purification, thermal regulating and passive cooling devices. Also, these sampled hotels insufficiently incorporated heat dissipation, moderation and dissipation strategies and techniques in their designand construction.

This study therefore concludes by specifying that passive cooling techniques have not generally been incorporated as strong features in the design of hotels in Minna, Nigeria as sustainable measures for fostering thermal comfort.

RECOMMENDATION

Passive cooling should be adopted as a design principle for hotels and hospitality buildings, as Government policy for health and wellbeing of hotel users as regards thermal comfort and sustainability. Local and indigenous vegetation, water bodies and other natural passive cooling features should be used in the development of hotels and hospitality buildings around North Central Nigeria, as this will make for better connection between people and the local climate within the particular area where the hotel is located as well as aid thermal comfort and wellbeing.

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Evaluation of Market Fire Hazard Awareness and Preparedness in Minna Metropolis

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Abstract

The impact of fire accidents has been severe in places where there is low or absence of fire hazard awareness and preparedness. The impact of fire outbreaks are not only on the individuals, but also on the market environments. This research was aimed at evaluating the level of fire hazard awareness and preparedness in Minna markets. The research was carried out with descriptive cross-sectional study, using interviewer-administered questionnaires as well as observational check lists. Findings show that, most of the people doing business in the market study areas of Minna are men. Larger percentages of the respondents doing business in the study markets are graduates. The study was concluded on the fact that fire outbreaks in the market study areas were caused by faulty electrical wiring and leaving the power on after the closing hour in the market. The majority of the respondents on the level of awareness were aware of the fire hazard and it consequences. The preparedness measure indicated that, they were not prepared against fire outbreaks. From the survey and observation conducted in Kure ultra-modern market and Kasuan-Gwari market, the fire bus would experience difficulties in driving-in because of poor access road within the markets, except Building material market that has well planned access road. The research hereby recommends that, the markets management in collaboration with office of the fire safety service and Niger State Emergency Management Authority to join hands in ensuring that all the fire hydrants within the market environments are functional at all time. Fire extinguishers also to be installed at the corridors of all the buildings at recommended distances

Keywords*: Fire Hazard Awareness and Fire Hazard preparedness.*

INTRODUCTION

This simple word called fire can cause total destruction of a building and the content in it, within a very few hours and its primary impact is the potential loss of the authenticity and originality, also causes our building heritage to lie valueless. It does not matter where one lives or where one works, fire knows no boundaries. Jaffari *et al.* (2018) put it straight that fire apart from being very useful and essentially good for human being on daily basis, can be very dangerous when it occurs especially where it is not needed, and not prepared for. Abdusalamet *et al*. (2016) accounts that, fire is essentially good for human beings, but it becomes a threat when it occurs unprepared for. Therefore, fire can be very useful, but it can also be very dangerous.

Fire safety awareness is the efforts put in place to know when fire is needed and not harmful, ability to know what to do to prevent fire as well as what action to take in case one happens. Fire hazard awareness and preparedness are part of the fire emergency management plans which is aimed at reduction of fire hazard. It involves perpetual series of planning, organizing, training, equipping, exercising, evaluating and improving method to ensure effective coordination and enhancement of capabilities to respond to fire hazards (FEMA, 2007).

Fire haz ard preparedness is an essential aspect in both environmental and occupational safety and health. Fires been an example of natural and physical hazards have affected many market environments and most of them are mainly caused by lack of awareness and preparedness in fire prevention, detection and fire control. All fire hazard preparedness is based on the knowledge about fire hazards, the likelihood of different causes of fire outbreaks and the likely effects on the built and natural environment (Comolotti, 2004) The gravity of loss of

life, injury sustained and loss of properties from a fire-related incident is one of the most serious problems a market can face. (FAU, 2002)

Wood (1990) explored the levels of awareness and preparedness for fire hazard in community members in Queensland and found that the level of fire safety awareness has direct influence on the level of preparedness. Also noted that, being ignorant of dangers of fire makes people ignore the installation of firefighting gadgets which will help save life and property in case of fire outbreak. One of the most recent market fire tragedies is that of Akesan market in Oyo. The Akesan market is known for the sale of a wide range of food items, local artifacts, clothing materials, household utensils and more. The fire ravaged and destroyed a lot of properties and also claimed three lives as attempts to rescue the goods and properties had failed. The inferno at the market, consuming almost all the shops and goods worth over N20 billion and left over 900 traders in shock and severe pains (Punch 5th January, 2020) Fire outbreak in the markets is potentially one of the most serious hazards that Nigeria faces at the moment.

LITERATURE REVIEW

Fire Hazard Preparedness Globally

Globally, many recurring fire incidences have been reported. Apart from loss of property and life, fire hazards have been associated with prevalence of diseases that have been reported to contribute about 1% of the global diseases burden (Leistikow *et al.,* 2000). The most devastating effects caused by fire in buildings, as recorded in literatures, include the collapse of the World Trade Centre (Cowlard *et al.*, 2013), the fire hazard in Sweden that occurred in 1998 killing 63 people (Cassuto & Tarnow 2003), and the Mumbai and Sharjah high-rise buildings fire incidences in India. This is just to mention but a few.

Africa as well has been affected by fire hazards. For instance, in 2011 Ghana recorded fifty three (53) institutional fire outbreaks (GNFS, 2011). Buildings compliance to fire safety preparedness regulations should be observed to reduce the impact of fires. A study on disaster risk assessment at the University of Ghana in Balme library found that the library annex had no balconies and had one exit for a three- storey building. The presence of balconies as a vital component in hazard response by acting as landing pads for trapped victims awaiting rescue was therefore overlooked (Adinku, 1999).

In 1994, Shauritanga secondary school in Kilimanjaro region was gutted by fire and more than 40 students died in one school dormitory. In July 2005, Nsumba secondary school in Mwanza had its dormitories gutted by fire on different days in the same week whereby students lost all their properties.

Ahmed *et al.* (2016) stated that, the observation of the physical fire prevention facilities of the health institutions both private and public hospitals, almost all of them reveal the same level of little preparedness looking at the current standards. A recent study by the Fire Disaster Prevention and Safety Awareness Association of Nigeria (FDPSAAN, 2008) revealed that there is significant low level of awareness on fire hazard in Nigeria. About 2% of 140 million people in the country have basic fire safety knowledge, while 80% lack such knowledge. Asodike and Abraham (2011) in their survey of safety practice in some schools in Port Harcourt added that, perhaps the rare incidence of fire outbreak in schools in Nigeria accounts for the lack of acquisition of fire extinguishers and organised periodic safety training for staff.

Ability to recognize the danger of fire is known as fire safety awareness. Ability to know what to do to prevent fire as well as what action to take in case one happens. All fire hazard preparedness is based on the knowledge about fire hazards, the likelihood of different causes of fire outbreaks and the likely effects on the built and natural environment. Comolotti (2004) stressed that; people with knowledge about fire disaster will acquire equipments such as fire extinguishers, fire blanket and smoke detectors among others to support response activities. They also prepare their families and employees to take immediate action to prevent death injury and destruction of property whenever disaster strikes. Safety regulations in U.K impose mandatory fire safety training to all employees working within a building, a construction area or any other busy area which helps provide employees with crucial information, develop skills such as those used in operating fire extinguishers and proper escape behaviors (James, 2016).

Ogajo, (2013), defines preparedness as a state of being ready to respond to hazard, crisis or any situation occurred due to an emergency. Additionally, he asserts that; good preparedness involves proper planning, training, resource allocation, and simulated fire hazard response exercise. It is important to conduct exercise to ensure that skills, equipment, and other resources can be effectively coordinated when an emergency occurs. Exercises provide a good opportunity to identify organizational and departmental shortcomings and take corrective action before an actual event occur. Preparedness is one of the important elements in hazard risk reduction and it encompasses community awareness, readiness to render appropriate responses and quick recovery (Ejeta *et al.* 2015).

RESEARCH METHODOLOGY

Study Design

This was a descriptive cross-sectional study using quantitative methods. This study evaluated the current state of fire hazards awareness and preparedness in three markets study, in Minna metropolis, using interviewer-administered questionnaires as well as observational check lists.

Study Population

The target populations were all Market masters, Fire Safety men in the market study areas, shop owners, buyers and sellers, Drivers and Police officers that interacts with the market environment of the study area on a daily basis, also included were some agencies such as NEMA and NSEMA. This population was easily accessible at the market of the study areas since they were opened on daily basis.

Sample Size and Sampling Techniques

With regards to the sampling size in the distribution of the questionnaire, the sampling size is determined based on the formula below considering the fact that the targeted population is known. Macdonald, (2006)

$n = (N / (1 + N (\alpha\ 2)$

Where; n = the expected sample size

N = the Known Population size

$\alpha = 0.05$

According to the information gotten from the market master of Kure Ultra modern markets, Minna, there are two thousand (2,000) shops in the market environment, though, there are some on –going constructions that are still in progress within the market environment. Information through market master in Kasuan-Gwari also revealed that about a thousand (1,000) shops are available and functional in the market while Building materials market

consists of accurate number of (283) two hundred and eighty three shops, information from the Mayor of the market and as well physical observation.

Instruments for data collection

Interviewer- administered questionnaires were used to collect data from the respondents, while the observational checklists evaluated the market buildings, the environment, and procedures on fire hazard preparedness.

DATA COLLECTION PROCEDURE

Semi-structured questionnaires questions were administered to the people who interact with market environment, while the observational checklists were also used to collect quantitative data focusing on compliance to fire safety preparedness

Results and Discussions

Data presentation and analysis of the respondents on level of awareness

Table 1 Socio- demographic characteristics of respondents (n=521)

Variables	Variable	Frequency	Percentage (%)
Gender	Male	279	53.6
	Female	242	46.4
Educational status	University	193	37.0
	Polytechnics/COE	114	21.9
	Secondary	129	24.8
	Primary	49	9.4
	Others	36	6.9
Working experience in the market	Less than 2years	127	24.5
	4-6years	92	17.7
	7-9years	112	21.6
	Over 10years	187	36.2
Decision of choice of the market	Good reputation	194	374
	Proximity	44	8.4
	Security/higher sales	72	14.1
	Forced by the govt.	211	40

Source: Authour's Field Survey, 2019

Among the respondents, 53.6% were male and 46.4% were female. The respondents were mostly possess the university grade as educational background is concerned with 37% and followed by secondary school certificate with 24.8% accompanied with the mean of 161 between the cadres of university and secondary, which shows that, the respondents are expected to be able to know and read all the signs for fire hazard preparedness situated an appropriate places. 36.2% have been relating with the market environment for over ten years 24.5% indicated that they are just less than two years of relating with the market. About 40.1% of the respondents were forced by the government into the market where they and 37.4% decided to be in their market environment due to good reputation the market has.

The level of awareness of respondents to fire hazards in the three markets understudy was explained in Figure 1. Where 62% of the people said they are very much aware of the fire hazard and all its atrausities. Meanwhile, 14.6% said they are slightly aware and 23.4% are not aware that fire can come into the market at al (Kure market). 60.7% of 153 number of responses out of 252respondants are aware, 11.9% of 30 number of responses out of 252respondants are slightly aware and, 27.4% of 69 number of responses out of 252respondants are not aware of fire and what is capable of doing at all.

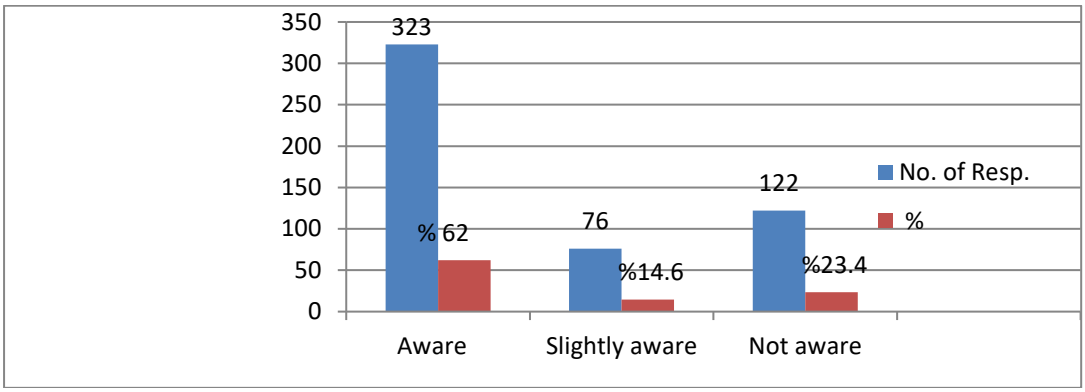

Figure 1 Shows the Level of fire Hazard Awareness

While in Kasuan-Gwari market 61.8% of 144 number of responses out of 233respondants are aware, with Kure market, 18.59% of 43 number of responses out of 233respondants are slightly aware and Kure market, 19.7% of 46 number of responses out of 233respondants are not aware of fire and what is capable of doing at all. At the same time, Building materials market records 72.2% of 25 number of responses out of 36respondants are aware), with Kure market, 8.3% of 3 number of responses out of 36respondants are slightly aware) and Kure market, 19.4% of 7 number of responses out of 36 are not aware of fire and what is capable of doing at all).

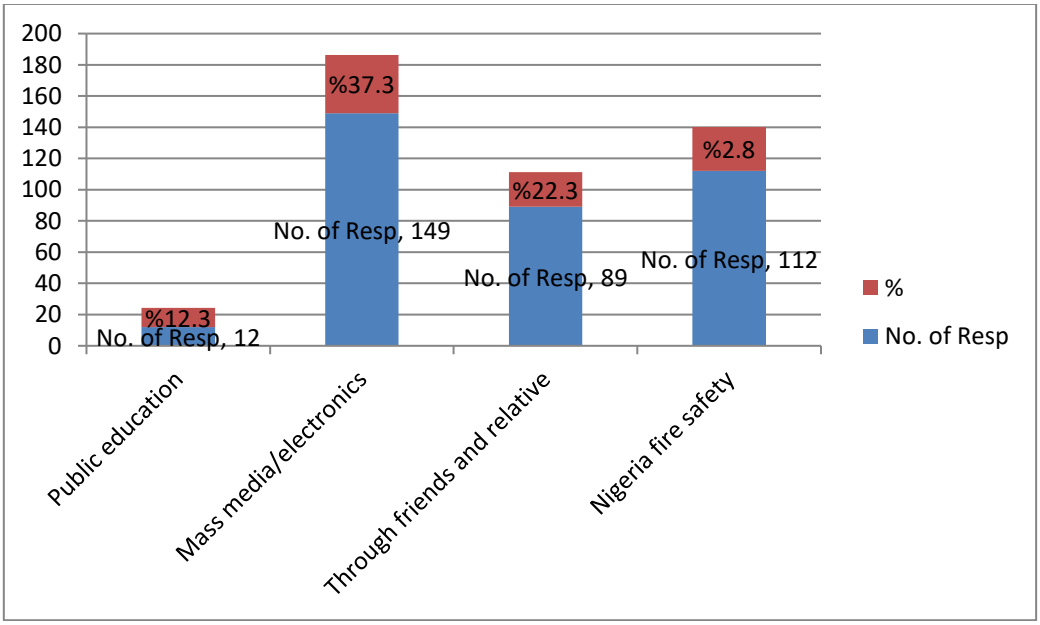

Figure 2 Shows the Source of fire hazard awareness

The Figure 2 shows the source of respondents fire hazard awareness, which indicates that only 12.3% of the people heard about fire hazard awareness through public education compare with 28.1% through Nigeria fire service. It was noticed that 22.3% got to know through their friends and relatives with 37.3% of them that are aware through mass media and electronics. This implies that public awareness is not strong enough in those markets' environment.

Table 2 Shows the factors that could be liable for market fire disaster in the market study areas.

Table 2 Shows the Factors That Could Be Liable for Market Fire Disaster

Variables	Names of the market						Total	
	Kure market		Kasuan Gwari		BuildingM.M		No. of resp.	%
	No. of Resp.	%	No. of Resp.	%	No. of Resp.	%		
Faulty electrical wiring	102	40.5	95	40.8	6	16.7	**203**	**38.9**
Leaving the light on after the closing hour in the market	58	23.0	80	34.3	9	25	**147**	**28.3**
Burning of tyre/refuse in the market	11	4.4	23	9.9	0	0	**34**	**6.5**
Natural hazard	81	32.1	35	15.0	21	58.3	**137**	**26.3**
Total	**252**	**100**	**233**		**36**	**100**	**521**	**100**

$x2$ = -28.12

$p - value = 0.05$

The results indicate that 38.9% of the respondents affirmatively concluded that faulty electrical wiring system is the main reason why market is always engulfed with fire. 28.3% of the responden t also confirmed that leaving the light on after the closing hour in the market could make the market environment to be prone to fire outbreak, while 26.3% of the respondents believes that fire in the market is usually caused by God naturally and 6.5% of the respondents said burning of tyres and refuses within the market environment is the main reason why market is set on fire.

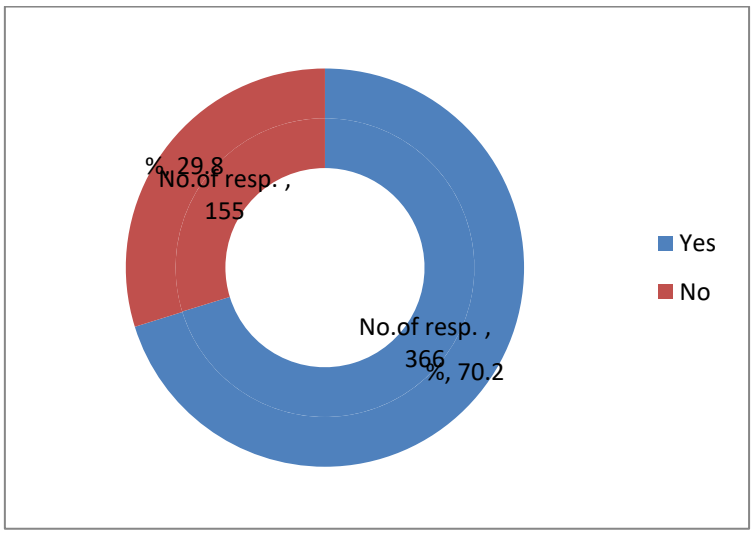

Figure 3 Indicates the awareness of fire safety precaution

The Figure 3 shows the awareness about fire safety precaution. The results prove that 70.2% of the respondents claimed to have heard about safety precaution before while only 29.8% respondents indicate that they are not aware of anything called fire safety precaution within the market environments. This implies that the awareness about fire safety precaution is on the high side, though the awareness needs to be more effective to make everyone in the market environments to be aware.

Table 3 Shows If They Know What to Do at the Event of Fire

Do you know what to do at the event of fire?	Kure Ultra modern market		Kasuan-Gwari market		Building M.M		Total	
	No.of resp.	%	No.of resp.	%	No.of resp.	%	No.of resp.	%
Yes	178	70.6	160	68.7	28	77.8	**366**	**70.2**
No	74	29.4	73	31.3	8	22.2	**155**	**29.8**
Total	**252**	**100**	**233**	**100**	**36**	**100**	**521**	**100**

$x2$ =0.0005

$p - value = 0.05$

Table 3 indicates what to do at the event of fire. 70.2% of the respondents show that they know what to do at the event of fire outbreak while only 29.8% of the respondents said they do not know what to do if fire should occur within the market environment.

Table 4 Shows What to Do At the Event of the Fire Outbreak

In case of fire incident, what are you going to do?	Names of the market						Total	
	Kure market		Kasua nGwari		Building M.M	No. of Resp.	No. of resp.	%
	%	No. of Resp.	%	No. of Resp.	%			
Applying the fire suppressing equipment	15	5.9	32	13.7	14	38.9	**61**	**11.7**
Call fire safety men	202	80.2	155	66.5	16	44.4	**373**	**71.6**
Run for my life	33	13.1	32	13.7	6	16.7	**71**	**13.6**
Packing of my goods	2	0.8	14	6.1	0	0	**16**	**3.1**
Total	**252**	**100**	**233**	**100**	**36**	**100**	**521**	**100**

Table 4 shows the response of the respondents on what to do at the event of fire. Though from the formal results shown in table 4, the higher percentage proved that they know what to do at the event of fire, the results in table 4.8 shows that 71.6% said they would call the fire safety men at the occurrence of fire outbreak, 13.6% which is the second higher percentage said they would rather run for their lives. 11.7% concluded that they would apply the fire suppressing equipments before any other thing and and 3.1% of the respondents would rather be packing the goods while the fire ravages the market environment before they would think of what next to do. This implies that higher percentages of the respondents know really knows what to do at the event of fire. Although, more orientations is needed for those who claims to be packing their goods and to those who said they would run for their lives. The reason been that, is has been affirmed that it is not the fire a times that kill people in the fire incident rather the flame, and where there is flame they may not seems to see clearly where exactly they are running to, except they are oriented to take the path called escape route.

Table 5 shows if they know how to operate any of the installed fire safety equipments. The result shows that 67% of the respondents cannot handle the installed fire safety equipments while 32.6% of the respondents indicate that they could operate the installed equipments. This implies that, more training is needed from the Nigerian Fire Safety men to ensure that larger percentage of the people in the market are capable of operating the installed equipments to reduce to impact of the fire before the fire safety men would arrive.

Table 5 Shows if they know how to operate any of the installed fire safety equipment

Do you know how to operate any of the installed fire safety equipments?	Kure Ultra modern market		Kasua nGwari market		Building M.M		Total	
	No.of resp.	%	No.of resp.	%	No.of resp.	%	No.of resp.	%
Yes	54	21.4	97	41.6	19	52.8	**170**	**32.6**
No	198	78.6	136	58.4	17	47.2	**351**	**67.4**
Total	**252**	**100**	**233**	**100**	**36**	**100**	**521**	**100**

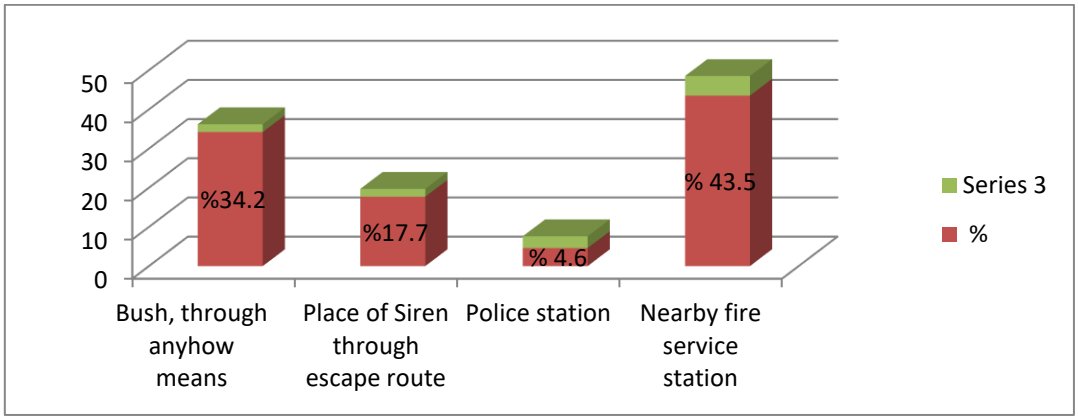

Figure 4 Shows Where Exactly To Run To At the Occurrence of Fire Incident

Figure 4 shows where people would run to at the occurrence of fire incident. The results shows that 43.5% of the respondents would run to nearby fire service station, 34.2% of the respondents took their ground to run into the bush not minding how while 17.7% of the respondents said they would run to place of siren through escape routes and 4.6% of the respondents are said to run to police station. This implies that a lot of people do not know where to run to in case of fire outbreak. More orientation from the fire safety men should also take place on this aspect.

Figure 5 shows that there should be stricter law and regulation to protect market environment.

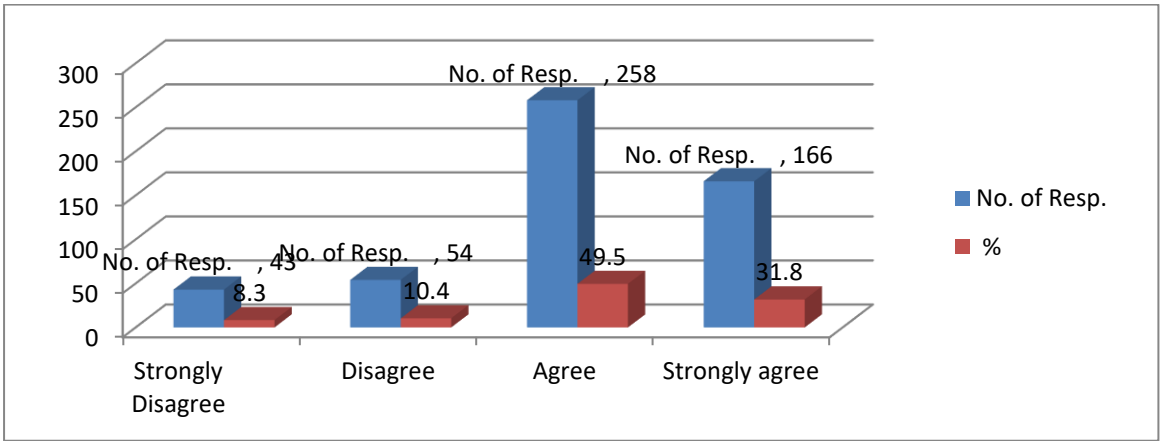

Figure 5 Shows That There Should Be Stricter Law and Regulation to protect market Environment

The responses of the respondents shows that 49.5% and 31.8% of the respondents agreed and strongly agreed respectively, that stricter laws and regulations to protect environment should be made while 10.4% and 8.3% said to have disagreed and strongly disagreed respectively to enforce any law and regulations on the before they protect the market environment

Preparedness Measure against Fire Hazard

There is adequate communication system in all the markets of the study area, especially with the closest neighbour. Also, the number of the fire safety office was released for all the users of the market in case of sudden fire hazard. It was noticed that only fire extinguishers were found within the office of fire safety. There was no other fire fighting equipments located in the market environment. Fire Hose, Fire Bucket and fire alarm system were all not available. The issue is peculiar to all the market study area. There has been a frequent inspection and maintenance of the available fire -fighting equipments, which are the fire extinguishers. Also there is regular fire drill and training on emergency service in case of fire outbreak. No muster point where people can converge in case of fire incidence in the entire market of the study area. Also, no availability of fire fighting emergency kits in the buildings of the market. The issue of access road for the fire fighter's vehicle to enter in case of fire is a major problem to be encountered in both Kure ultra modern market and Kasuan-Gwari markets. The case is a little bit different in Building materials market as there is well planned access road for easy movements within the market of the study area. No fire hydrants within the market for emergency

CONCLUSION

The following conclusions can be drawn on the basis of the objectives in the study are:

The study was aimed at evaluating the level of awareness and preparedness with mitigation measures that are put in place against fire hazard in the markets of the study area. This was in relation to the fact that the inferno resulting into serious loss of properties had taken place in the market, though in only Kure Ultra modern market among the three markets of the study area. The results are to be of help to the fire safety authority in the state as well as National Emergency Management Authority (NEMA) and Niger State Emergency Management Authority (NSEMA) in order to put in appropriate preparedness, awareness and mitigation measures.

It was noticed that, the majority of the respondents on the level of awareness were aware of the fire hazard and all its associated problems. On the level of preparedness measure, they were not prepared in any way against fire outbreaks. With regards to organizations that are prompt and readily respond to the market inferno, Niger State Emergency Management Authority (NSEMA) and National Emergency Management Authority (NEMA) were identified as the most responsive organisations

RECOMMENDATIONS

There should be adequate awareness and trainings for the people in the market on how to handle fire safety equipments. The management of the markets of the study area in collaboration with office of the fire safety service (both federal and state) and Niger State Emergency Management Authority (NSEMA) to join hands together in ensuring that all the fire hydrants within the market environments are functional at all time. They should also in little capacity provide fire extinguishers to be installed at the corridors of all the buildings.

It is recommended that, the federal government should adopt all the state fire service men (staff) to become federal fire service staff, so that there could be equal level of treatment for the safety men in the country. According to a state fire service officers in the markets study area, there are some human safety equipments supplied by the federal government and state

government could not afford, therefore limiting the state fire service men to perform as expected. The state government should try and get a firefighting bus stationed permanently in Kure Ultra modern market because of the largeness in size. Some of the fire safety equipments especially the fire extinguishers that are supposed to be stationed at the corridor of the buildings should not be stored in the office of the fire safety service but rather be positioned to where they ought to be.

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Employing Proxemics Communication Strategies in Evaluating Prototype Design in Educational Buildings

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Abstract:
Prototype in architecture is a term used to define the use of design of a building type more than once. It is usually adaptation of the earlier designed or executed project. Adaptation of building design with little or no modification is a common practice in Bayero University, Kano. Using principles of proxemics, this research was aimed at evaluating the suitability of the adopted prototype design for the Department of Architecture, in Block J, Faculty of Earth and Environmental Sciences, Bayero University, Kano. Content analysis and observations were employed as research strategies. The focus was on the learning spaces which included classrooms, design studios and an e-studio. Similarly, NUC Basic Minimum Academic Standards (BMAS) for space requirement was also used as a basis for comparison. The data was analysed using Content Analysis. The findings showed that the classrooms and design studios were appropriate in terms of size and capacity but fall short of the minimum number required for Architectural training based on the standards. Similarly, the e-studio was found to be unsuitable in terms of size and capacity for its users as it is the conversion of supposedly classroom space. The research has established the inappropriateness of adopting prototype designs in tertiary educational buildings for different users/functions and emphasized on the use of proxemics by designers for better functionality.

Keywords: Prototype buildings, Proxemics, Educational Buildings.

INTRODUCTION

Prototype in architecture is a term used to define the reuse of a building type or building design. Prototypes have acquired certain prominence and visibility in recent times (Guggenheim, 2014). The idea of prototyping in architecture has been in existence for a while but until recently, it has been used primarily to test and refine elements of buildings, mainly during construction or the aesthetics. Currently, built prototypes are used to enhance environmental performance and reduce risks which translate into reducing cost.

Prototype designs have widely been adapted under residential buildings but recently, educational buildings have started adapting the trend as well. It has been adapted mostly in primary and secondary schools because of their similarities. All stages of education from primary to secondary, use basic spaces which include classrooms and libraries, therefore making a design pattern which could be used to generate a prototype (Alaska Department of Education, 1998). Although the functions may look the same, tertiary education requires more spaces to fulfil its function. These spaces may range between different disciplines.

Prototype design is a common feature of buildings in Bayero University, Kano. It can be seen in many buildings in the university, for instance, the Centre for Renewable Energy and the Centre for Dry Land Agriculture, Faculty of Agriculture; the Administrative Block at the

Faculty of Earth and Environmental Sciences and the Administrative Block at the Faculty of Law. The Faculty of Earth and Environmental Sciences is not an exception as Block J, which houses the Departments of Architecture, Estate Management and Quantity Survey; is a prototype of Block C, which houses the Departments of Urban and Regional Planning and Geography. Both buildings share the same design, size and shape. It became pertinent to establish the compatibility or otherwise of the adaptation with little modification of spaces meant for department of Geography to house Architecture Department.

Human beings are associated with space in their interactions which is a fusion of thermal, auditory, visual, olfactory and kinaesthetic sensory inputs. These sensory inputs were often culturally patterned and moulded according to their geographical and levels of adaptation (Okolie & Okoye, 2012). As such, from the early study of culture, it was established that interaction between two people of different culture, context or settings may differ emotionally leading to different relationships (Nast, 2005). The interrelated observations and theories of man's use of space as a specialized elaboration of culture is called Proxemics as shown in Figure 1. Proxemics is a term coined in 1963 by the cultural anthropologist Edward T. Hall. Proxemics in relation to design is a branch of non-verbal communication that deals with the amount of space and distance appropriate between one person to the other(s) (N. Marquardt & Greenberg, 2015). Like all basic communicative process, proxemics, is concerned more with structure than content as it deals with basic human situations according human culture ordinarily hidden from their conscious awareness (Grønbæk et al., 2020). Therefore, proxemics frequently leads to new understandings about specific cultures, as well as discoveries of generalized concept of culture which is an extension of basic biological processes. According to McHarg (1963), "no species can exist without an environment, no species can exist in an environment of its exclusive creation". As such, every human must adjust according to the space and environment to survive and attain comfort.

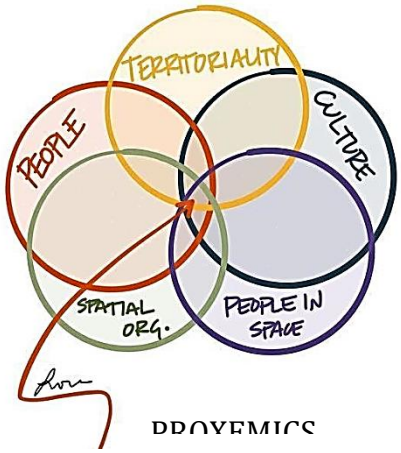

Figure 1: Interrelation of various theories on human culture and actions

Source:pinterest.com

Proxemics Required for Educational Facilities

From Hall's (1966) interpersonal zones, the common zones to be found within educational facilities (in this case, classrooms, studios, and e-studios) include the intimate zone for close friends or family members which is between 0-0.5m, the personal zone for friendly acquaintances or same department colleagues which is between 0.5m-1m, and the social zone for friends of friends, casual acquaintances, and fellow colleagues from other departments which is between 1m-4m. In using proxemics for design of educational facilities, it is important to recognize the interaction between the users and their environment, as classrooms and studios should not only reflect aesthetics, but also achieve functional furniture arrangement and good spatial layouts. Also, the spaces should be designed to accommodate the different personality types, cultural differences and social norms of the students (Thompson, 2012).

The design of learning spaces can have an impact on student productivity, motivation, and performance; therefore, designers should keep in mind appropriate spatial configurations and

interpersonal zones that will accommodate all students. According to McCorskey & McVetta (1978), the traditional classroom arrangement restricts student to student interaction because the arrangement only focuses on the teacher, but configuring the classroom's layout into a U-shape arrangement is the best both student to student and student to teacher interactions. Therefore, classrooms and studios can adopt Hall's social distance zones (1m-4m) while also adopting the U-shape arrangement. This will allow both personal and social interactions, but also give enough space for privacy and territoriality.

Therefore, this gives a new dimension of considerations to be made before adopting prototypes. The zones may differ from different fields of studies. The above dimensions can be adopted for design studios, and library settings. Also, the allocation of space should be dependent on the space available.

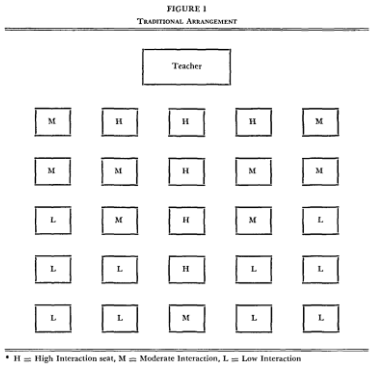

Figure 11: Traditional Arrangement Source: (McCorskey & McVetta, 1978)

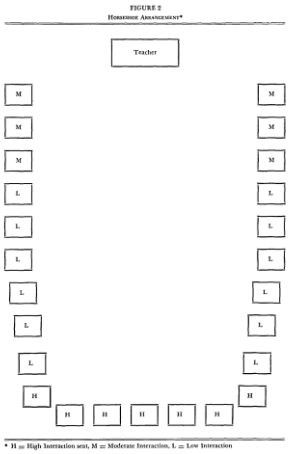

Figure 12: U-Shape Arrangement Source: (McCorskey & McVetta, 1978)

Proxemic Fundamentals

Like all other cues of social behaviour (Knapp and Hall, 1972), proxemics has proven that the way people use, organize and share space during social gatherings and activities is a nonverbal communication indicating some cue and interpretation of their social acceptance. Nonverbal behavioural has a wide spectrum of cues such as: facial expressions, intonations, gestures,

postures, which can be interpreted to convey information about social and aspects of human interaction (attitudes, personality, emotions) (Richmond and McCroskey, 1995).

a) Interpersonal Distances

Interpersonal distances according to the earliest investigations on proxemics has shown that people tend to organize the space around them in terms of four concentric zones associated to different degrees of intimacy as shown in Figure 5 (Grønbæk et al., 2020).

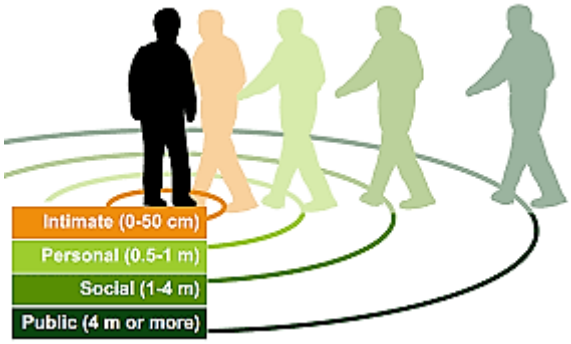

Figure 5: Hall's Proxemic Zones

i. Intimate Zone: distances for unmistakable interaction with another body. This zone is typically unfavourable to other non-intimate persons, except in those where intrusion cannot be avoided (e.g., in elevators).

ii. Personal Zone: refer to distances when interacting with familiar people, such as colleagues or friends. This zone is suitable for having personal conversations without feeling under pressure.

iii. Socio-Consultative Zone: this zone refers to distances for formal and detached contacts. This zone is typical for business conversations, consultation with professionals (lawyers, doctors, officers) or seller-customer interactions.

iv. Public zone: This zone refers to distances for non-personal interaction with others. It is a zone typical for teachers, speakers in front of a large audience, theatre actors or interpersonal interactions in presence of some physical barrier.

b) Spatial Arrangement: The F Formations

An F-formation consists of two or more persons engaged in a joint activity (Marquardt, et. al., 2012). It refers to the proper organization of social spaces among the people. The participants bodies define three circular regions: the inner O-space, the ring of P-space, and the surrounding R-space as shown in Figure 6.

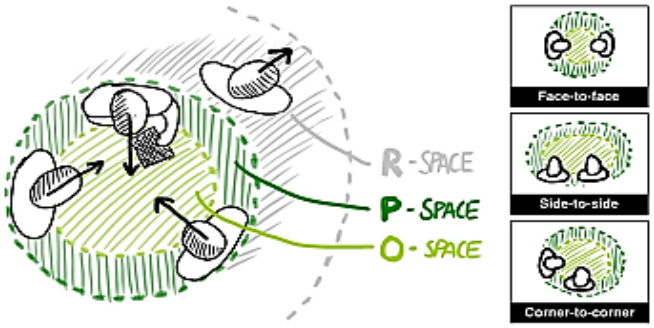

Figure 6: F Formations
Source: Marquardt, et. al., 2012

There 4 different F- Formations according to Marquardt, et. al. (2012) is explained as follows:

i. Vis-a-Vis: An F-formation where the absolute value of the angle between participants is approximately 180^0, and both participants share an O-space.
ii. L-shape: An F-formation in where the absolute value of the angle between participants is approximately 90^0, and both participants share an O-space.
iii. Side-by-Side: An F-formation in where the absolute value of the angle between participants is approximately 0^0, and both participants share an O-space.
iv. Circle: An F-formation where the configuration between adjacent participants considered to be a hybrid between L-shaped and a Side-by-Side F-formation.

The Setting of The Faculty of Earth and Environmental Sciences BUK

The Faculty of Earth and Environmental Sciences is a faculty designed with blocks of buildings organised in a symmetrical pattern where the blocks of buildings on one side are a replica of the block of buildings on the other. Block J and Block C are of typical building forms as found in other faculties in the university. Block J houses the departments of Architecture on the first floor while Estate Management and Quantity Survey resides in the ground floor. As for Block C the departments of Urban and Regional Planning are on the ground floor while Geography is on first floor. The department shares four lecture theatres with deanery building at the centre. In addition, two blocks of round buildings and two blocks of U-shaped buildings are office accommodation for the academic staff.

Space Requirements for Architecture Programme

Architecture being a course with many peculiarities, requires certain facilities which other disciplines do not require. Some of the basic requirements of the department as stated in the Benchmark Minimum Academic Standards (BMAS) provided by National Universities Commission (NUC) can be seen in Table 1.

Table 1: Minimum Requirements for Architecture Program Academic Spaces

Space	Use	Minimum Area (m2)
Studio Space/student	Students	3
Exhibition Space	Academic	0.5
Computer Lab	Academic	2 (50 users)
Storage Space/student	Students	0.2

The BMAS also gave more details on classroom and studio spacing in which it stated the following:

"A minimum of two classroom spaces (capacity depends on enrolment) will be required for the undergraduate program in Architecture. This provision is based on an assumption of six

hours of contact per day for each year of study. A suitably furnished and equipped studio space is recommended for each year of study."

Using Comparative Content analysis of the first floor plans of the two buildings (Elo & Kyngäs, 2008), it is clear that even though the size, shape and floor area is the same, the space allocation for functions is not the same. The learning facilities in Block C (Figure 2) has five classrooms, a computer laboratory, a cartography laboratory, a geography studio and a library/data room, while Block J (Figure 3) has three classrooms, one e-studio, a modelling studio, a library/data room and 4 design studios. These spaces utilisation in the two buildings clearly differs except for the classrooms and library/data rooms.

Even though Geography department has studios but is not the same with design studios for Architecture departments as the furniture and other requirements is not the same. The corresponding space provided for laboratory in Block C has been transformed to studio spaces in Block J. Even though the computer laboratory in Block C and the e-studio in Block J might serve the same purpose but they are not of the same size and capacity. All these comparisons clarify that indeed, Block J is a prototype of Block C being both educational buildings, but there is a difference in usage of spaces between the two.

Block J as shown in Figure 3 was the original floor plan designed for the department of architecture which was later modified. The department currently has two classrooms, an e-studio, modelling studio and 3 design studios as shown in Figure 4. The originally planned level 2 studio is being used as a laboratory for Geology Department, and lecture room 2 is empty and unfurnished

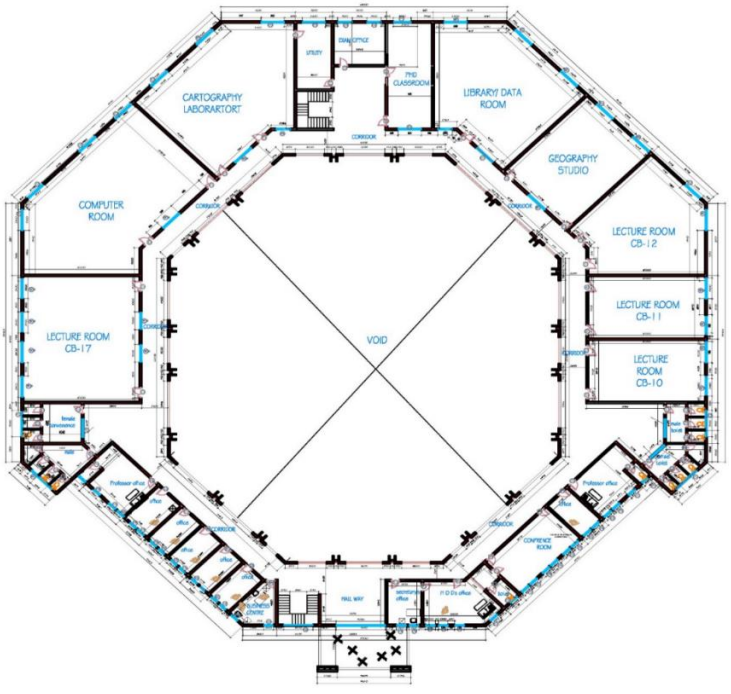

Figure 2: Architectural Floor Plan of Geography Department (Block C)

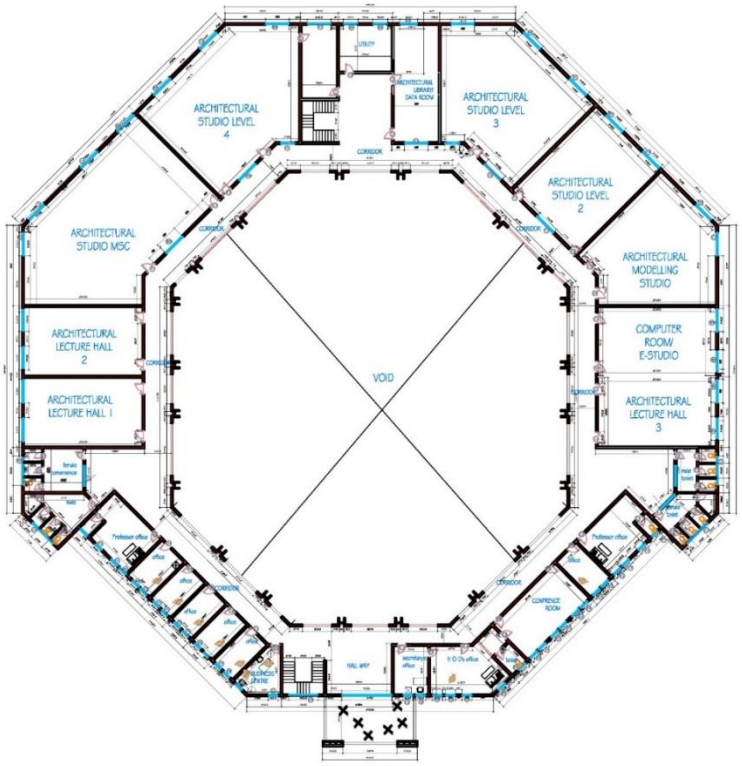

Figure 3: Original Architectural Floor Plan of Architecture Department (Block J)

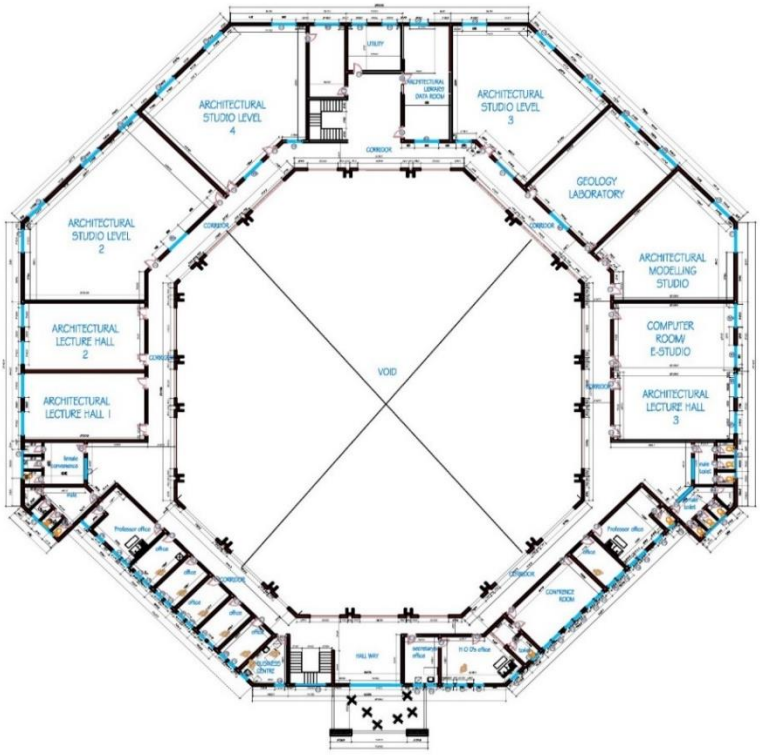

Figure 4: Current Floor Plan of Architecture Department (Block J)

Results and Findings

Observations were carried out on the learning facilities: classrooms, e-studio, and design studios. Space/size, capacity, number of spaces and Space-activity relationship are the parameters that guided the study for all the spaces studied. The findings based on the content analysis are discussed as follows:

i. Classrooms: It was observed that there were only two classrooms available. They both have same shape and size being rectangular with a floor area of 82.92m² and a capacity of 88 seats. Thus, they can only be used by two classes at a time.

Figure 7: View of a Classroom

Figure 8: View of a Classroom

ii. E-studio: There is only one e-studio present in the department. It has a floor area of 82.92m², rectangular and a capacity of 38 workstations for students. The e-studio is only used by level 2 students as that is the only level that takes classes that require an e-studio. It was observed that students either share workstations or take the class in groups.

iii. Design studios: There are 3 design studios for levels 2, 3 and 4. They have a floor area of 228.55m², 167.84m², and 181.79m², and have a capacity of 50 workstations each. In trying to adopt with the shape of the building, the shapes of the design studios were altered from the conventional square/rectangular shape which gives more flexibility in the arrangement of drawing tables, to an irregular polygon shape. It was observed that level one students, who do not have a studio, usually share a studio with level two students or use the modelling studio for their activities.

Figure 9: View of a Studio

Figure 10: View of a Studio

From the observation, the results were tabulated.

Table 2: Results from Observation

S/N	Space	Size (m^2)	Capacity	Number Available
1.	Classroom	82.92	88 seats	2
2.	E-studio	82.92	38 workstations	1
3.	Level 2 Studio	228.55	50 workstations	-
4.	Level 3 Studio	167.84	50 workstations	-
5.	Level 4 Studio	181.79	50 workstations	-

From the information obtained from the BMAS, an analysis was made to check the suitability of the learning spaces. The sizes were checked by using the data collected. The sizes were divided by the minimum area values obtained from Table 1.

Table 11: Proposed Capacity for Spaces Using BMAS Standards

S/N	Space	Size (m^2)	Current Capacity	Minimum Area Per Student (m^2)	Proposed Capacity
1.	E-studio	82.92	38 workstations	2	41
2.	Level 2 Studio	228.55	50 workstations	3	76
3.	Level 3 Studio	167.84	50 workstations	3	56
4.	Level 4 Studio	181.79	50 workstations	3	61

Comparing the capacities from table 2 and 3, it shows that the design studios are of adequate size, but the e-studio having a capacity of 38 workstations and the ability of having 41 workstations is not up to the BMAS standard. Due to the design of the building being an adopted prototype design, that means the shape and size of building was adopted without any regard for the needs of the department, and the results show that the spaces provided do not fully satisfy the spatial needs of the department.

CONCLUSIONS

After critical analysis, focusing on the learning spaces which included classrooms, an e-studio and design studios. Spaces such as classrooms and design studios spaces were found to be appropriate in terms of size and capacity but not insufficient in number based on BMAS. Similarly, the e-studio even though sufficient in terms of number, but when compared with the BMAS, it is rather small and unable to accommodate the required capacity.

Close examination of how the spaces were used based on the principles of proxemics, the nonverbal communication of some cue and interpretation indicates the occupant's lack of social acceptance. This cannot be disconnected to the so many aspects of design implication that was not given due consideration during adoption/modification. This shows that even though prototypes are adopted for other type of educational buildings like primary and secondary schools because their space usage is the same, it will be unsuitable to be adopted for tertiary institutions based on the findings of this research.

From the findings and conclusions drawn from this research, the following recommendations are advised:

1. Proxemic standards should be fully examined before adopting a prototype design building as the configuration of the design may not be suitable for the uses/functions of the new building users.
2. Due to the peculiarities of each course/program undergone in universities, especially professional courses/programs where special requirements and equipment are needed,

it is advised that these courses/programs are provided with facilities that are designed to suit the intended purpose of users.

3. The end users of the facilities, which are the students, should be included in the strategic planning for universities as relying on the BMAS alone, which was developed in this research is insufficient in achieving efficient learning facilities.
4. Policy makers should take into consideration the prospect for growth in the design of learning facilities as some new courses/programs have the tendency to expand over time.

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Towards Developing Standards for Earthquake Resilience and Sustainability of Public Buildings in Abuja, Nigeria.

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Abstract:
Architecture in different countries has proven to be pragmatic and dynamic in nature, because of how we have seen it evolve over the years. Natural and manmade disasters are some of the factors that cause this dynamic nature of design and construction. Nigeria has experienced and documented Earthquakes since 1933 to date. On the fifth to seventh of September 2018, Abuja experienced an Earth Tremor and the National Space Research and Development Agency (NSRDA) has identified selected locations in Bayelsa, Ogun, Oyo, Kaduna and Abuja as hot spot for Earthquake. This information has drawn the attention of the professionals of the built environment to draw out strategies and plans to stand out in the event of an occurrence. This study is aimed at accessing the need for developing standards in design and construction of buildings to resist future occurrences of Tremor in the Federal Capital Territory (FCT) Abuja. Qualitative method of Research was used and questionnaires were administered to different professionals in the building industry, some of the tools employed were indirect interviews. An average of 90% of professionals strongly agrees to the need for developing standards for earthquake resilient buildings along seismic fault lines in Abuja.However it was recommended that there is a need to first of all identify the areas along seismic fault lines by using state of the art Seismometer and then set policies and standards that govern design and construction in those locations.

Keywords: Standards, Earthquake, Seismic wave, Sustainability, Resilience.

BACKGROUND

Studies have proven that the earth is in constant motion in two ways, on its axis and around its orbit. This information tells us that the earth could react to different forces trying to adjust or settle while in motion, because about seventy percent (70%) of the earth is water (). These movements cause sea floor spreading at high pressure point and transform faults which are known as those on land and at the margins of continental tectonic plate. The action of these plates rubbing against one another while moving in opposite direction, results to an intense seismic wave that translates to an earth Tremor or earthquake in a community.

Resilience as regards to hazardous events is defined as "the ability to plan and create against, to absorb or resuscitate from, and better yet, adapt to adverse situations" (NAC 2012). Resilience is also known as the ability to resist and recover from intentional attacks, accidents, or act of nature. For the purpose of this research, we will consider resilience to earthquake and earth tremor activities to the earth's crust or lithosphere.

Codes and standards that are adopted and enforced are the determinant of high performance of the built environment (T, McAllister, 2013). Standard sand Codes for structures and buildings provide minimum performance criteria for hazardous events, with some differences in performance requirements between hazards like earthquake, hurricane, flood and extreme weather condition.

This study is aimed at assessing the need to develop standards and policies for the design and construction of buildings along fault lines, to be resilient to earthquake and to also plan for the timely recovery from Earthquake in the Federal Capital Territory (FCT) Abuja. In recent years, earth Tremors and Earthquakes have been experienced in different part of Nigeria like; Bayelsa, Ogun, Oyo, Kaduna and Abuja, which have been listed as hot zones for possible frequent earthquake occurrence by the National Space Research and Development Agency

(NSRDA). This study is of significance to the professionals of the built environment, as guardians of our own expertise. The joy of every professional is to solve problems with their creativity, but in a situation where disasters like Earthquakes reduces the life span of this creative work. We will wake to no Heritage sites or buildings that can translate centuries of culture and city administrative operations of a people, it is also of significance to the government of Nigeria, to create Standards and Policies that will save lives and properties in the advent of an Earthquake, thereby reducing the economic menace that results to millions of citizens dead or homeless.

The scope of the study is carried out within the Federal Capital Territory (FCT) of Nigeria, Abuja. It is limited to the professionals of the built environment in five (5) Federal agencies of Nigeria and two (2) professional bodies of the built environment namely; Federal Housing Authority (FHA), National Emergency management Agency (NEMA), Nigerian Geological Survey Agency (NGSA), Federal Capital Development Agency (FCDA), Department of Development Control (DDC) Abuja, The Nigerian institute of Architects (NIA) and the Nigerian Society of Engineers (NSE). Interviews were conducted to each category or agency focusing on the need to develop standards and policies to guide the design and construction of buildings along seismic fault lines or seismically active areas in Abuja to be resilient to earthquakes.

Concept of earthquake

An earthquake is the trembling of the Earth's surface, caused by the rapid emission of energy from the Earth's crust that creates seismic waves. Earthquakes differ in magnitude and nature from those that are so weak that they cannot be felt to those violent enough to toss people around and destroy whole cities (ISBN, 2011).. The lithosphere (earth's crust) is made up of several pieces, called plates. They extend to the mid-oceans and are called mid oceanic plates while the rest are continental plates. The plates are moved around by the motion of the earth along its axis and orbit at through the deepest part of the ocean. These plates are constantly colliding into each other, withdrawing away from each other, or slide past each other. Because of the size of a tectonic plate the movement is not felt by humans until there is a collision.

Types, causes and effects of earthquakes

Earthquakes are different in nature and effect depending on the type of earthquake. We have seven types of earthquakes; Tectonic earthquakes, Volcanic earthquakes, Earthquake Fault source, Dilatancy in the crustal rocks, Earthquakes Explosion, Large reservoir induced earthquakes and earthquake as a result of collapse (BA Bolt, 2001). Earthquake has a devastating and terrible effect on lives and structures. Many infrastructures are destroyed due to earthquake while properties worth billions of dollars have been lost across the world in a period of 50 years in only Asia and America (BA Bolt, 2001). The environmental effects of it are that including surface faulting, tectonic uplift and subsidence, tsunamis, soilliquefaction, ground resonance (See Figure 1).

The Atlantic landslides and ground failure either directly linked to a quake source or provoked by the ground shaking.

Figure 1 Ecuador earthquake, 2016 after a 7.7 magnitude.Source: P, Brannen 2016.

Seismicity of the world

Readings from different seismographic observation stations for earthquake have been documented and calculated to locate the epicentre of earthquake distribution around the world. A specific ring of seismic reaction divides large oceanic and continental regions usually not completely away from earthquake epicentres (BA BOLT, 2001). Some concentrations of earthquake epicentres can be seen in the oceanic ridge, which is along the Atlantic and Indian Oceans. The geological activities that occur all through this global ridge system are confirmed by land forms like mountain peaks and deep rift valleys. We have regular volcanic eruptions, and earthquakes occurring along continental ridges often occur in multiples, so that hundreds of shocks are concentrated in a small area within a short time.

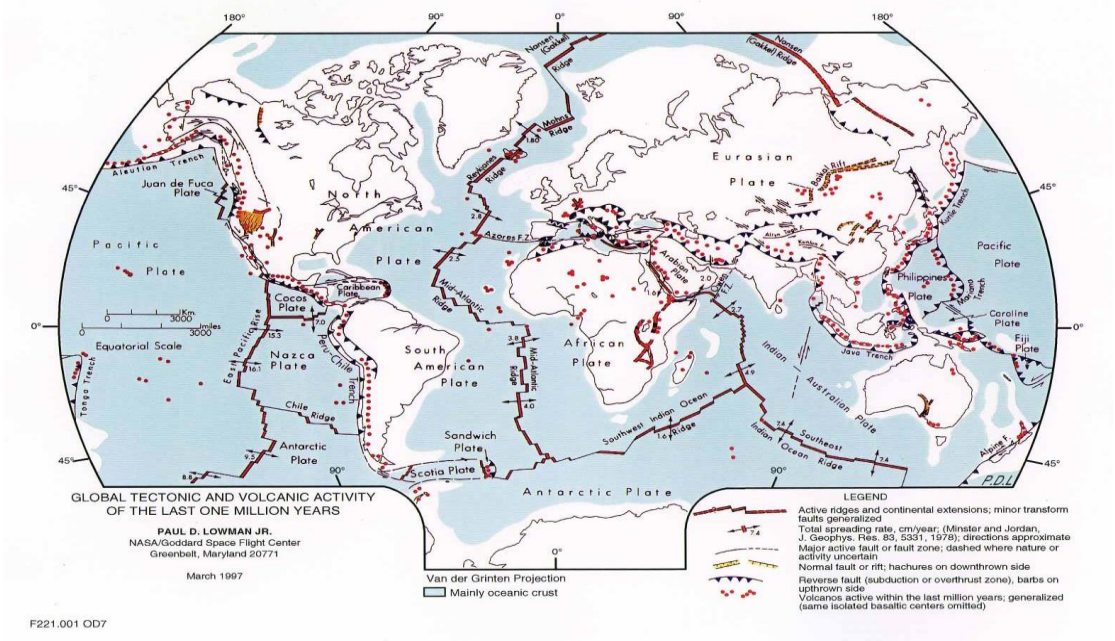


Figure 2 seismotectonic map of the world Source; D. Paul, J.R Lowman, 1997

Seismotectonic Map of Africa

Africa is made up of various interesting geological structures which includes areas of active deformation. Regions that are seismically active are mainly located at the rift zones, mountain belt, thrust and folds, transform faults and volcanic fields. The seismotectonic map of Africa (CGMW, 2010) zoned Africa into six (6) different seismotectonic active provinces;

- Western-central Africa
- North-West Africa
- North-East Africa
- Central Africa
- East-Africa
- South African shield and the cape fold belt.

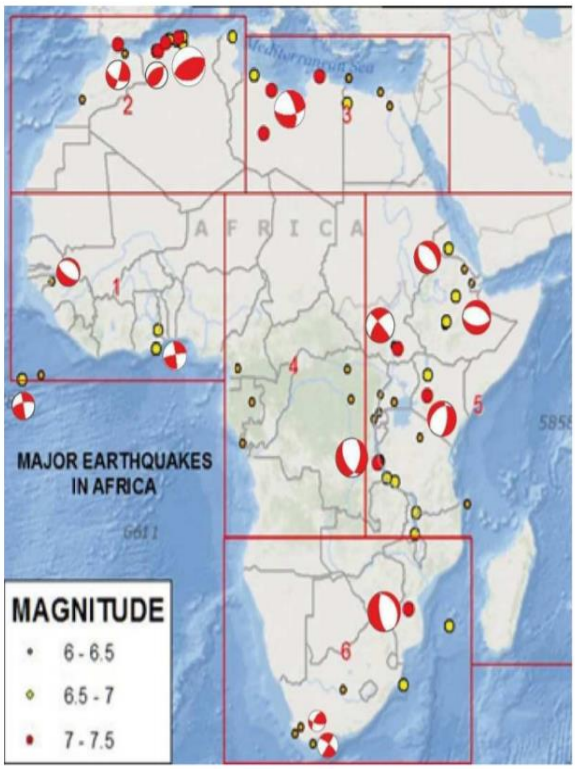


Figure 3.Seistectonic Zones in Africa

Source;database africa-igcp-601

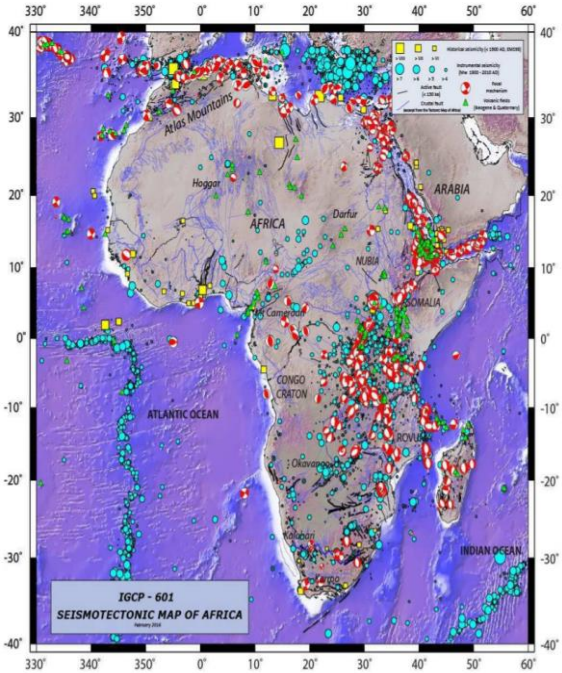


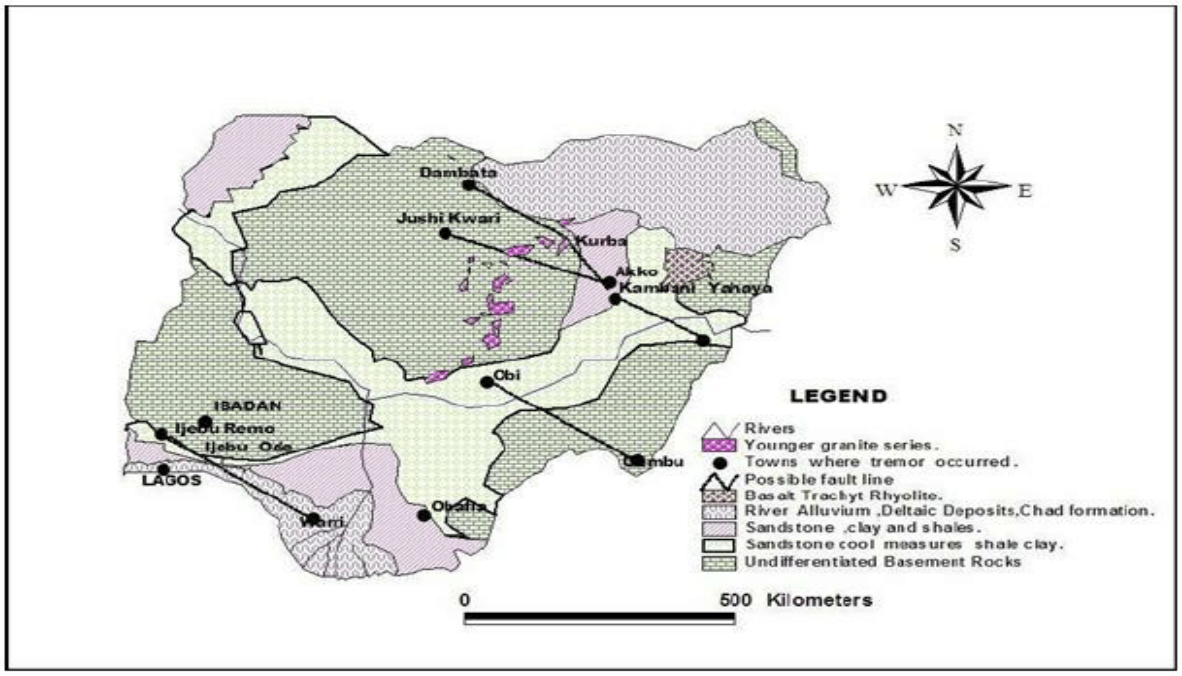
Figure 4.Seismotectonic Magnitude in Africa

source; database africa-igcp-601

History of earthquakes in Nigeria

Various studies have been carried out as regards the seismic fault lines in Abuja and different part of the country. Since 1923 when the first tremor was felt in the country, over thirty – nine (39) events have been reported. Of these 39 seismic events, less than 20% were recorded

instrumentally. The tremors felt in more than one locality at a time is estimated to be over forty-eight (48) instances and experienced in various communities cutting across about twenty-two (22) states of the federation including the Federal Capital City, Abuja giving, a percentage coverage of about 60%. The number of states in each region affected by the tremor is shown in figure 3. The Bar chart, figure 9 shows the number of seismic events experienced in each state per region. From Table 6, about 52% of the events occurred in the SouthWestern parts of the country with Ogun and Oyo states been the most affected occurring mainly within the Ijebu-ode and Ibadan axis.



Source; Akpan and Yakubu, 2010
Figure. 5 map of nigeria showing seismic fault lines

This axis lies along the Ifewara-Zungeru lineament. Seismic events have been recorded in Nigeria since 1923 (Adepelumi et al., 2008) with about ten related seismic activities experienced in 2016 alone. Tsalha et al., (2015) reported about 31 incidences with about four emanating from neighbouring countries of Ghana and Cameroun. The tremors are distributed among the basement complex and the sedimentary basins. Compiled from various sources including Osagie (2008); Ofonime and Yakubu (2010); Eze et al (2011) &Tsalha et al., 2015 and other sources and in addition to the most recent Abuja tremor incidence, the number of seismic events recorded in the country till date (2018) is estimated to be about 39 in total with Oyo and Ogun states been the most affected.

Nwankwoala, 2018established that Nigeria is at the risk of undergoing a terrible earthquake in the future. It's likely to have a magnitude as high as 6.0 in the year 2020; 6.5 is expected between the year 2021 to 2022; in 2025 and 2026, 7.0 is expected and 7.1 in the year 2028. A 9%and 36.79% probability of a 7.1 magnitude earthquake may occur from 2019 to 2028.

Therefore, this requires for monitoring stations around the country and FCT, Abuja to constantly read seismic waves and analise the data to know the nature of the type of earthquake predominant in an area and the right measures to be proposed for buildings and other structures.

Table 1; showing the earthquake occurencies in Nigeria, Source; Nwankwoala, 2018.

S/N	Date	Time	Felt Area	State	Intern city/Magnitude	Probable Epicenter	Remarks
1	1933		Warri Ohafia	Delta Abia			
2	1939-06-22	19:19:26	Lagos, Ibadan Ile-Ife	Lagos, Oyo, Osun	6.5(Ml)	AkwanpainFasal in Ghana	
3	1948	-	Ibadan	Oyo	-	Close to Ibadan	
4	1949	-	Ibadan	Oyo	-	Close to Ibadan	
5	1961-07.02	15:42	Ohafia	Abia		Close to Ohafia Area	
6	1963-12.21	18:30	Ijebu-Ode	Ogun	V	Close to Ijebu-Ode	
7	1975-07:01		Damhara	Kano	-		
8	1981	12:00	Kundunu		III	At Kudunu Village	
9	1982-10:16	-	Jalingo-Gembu	Taraba	III	Close to Cameroom Volcanle Line	
10	1984-07.12		Ijebu-Remo	Ogun	Iv	Close to Ijebu Ode	House Rocked People Come Outside Cracks in Builkling
11	1984-07-28	12:10	Ijebu-Ode, Ibadan, Shagamu, Abeokuta	Ogun, Oyo	vi	Closes to Ijebu-Ode	Houses Rocked People Came Outside
12	1984-08-02	10:20	Ibadan, OyuIjebu-Ode ShagamuAbeakuta Ijebu Remo	Oyo, Ogun	v	Close to Ijebu-Ode	Cracks in buildings
13	1984-12-08		Yola	Adamawa	iii	Close to Cameroun Volcanic line	
14	1985-06-18	21:00	Kambani-Yaya	Bauchi	v	KambaniYaya	Surface Fractures
15	1986	10:45	Obi	Benue	iii	Close to Obi Town	
16	1986	-	Abeokuta	Ogun			
17	1987-01-27		Gembu	Taraba	v	Close to Cameroon Volcanic line	
18	1987-03-19		Akko	Gambu	iv	Close to Akko	
19	1987-05-24		Kurba	Bauchi	iii	Close to Kurba	
20	1985-04		Amauzu Ede-Obela	Anambra			12km Of Land Cracked, Zinc house cracked
21	1988-05-14	12,17	Lagos	Lagos	V	Close to Lagos	
22	1988-09		Oseterun Hills	Gombe			Cracks caused by Volcanic eruption, lost three hectares
23	1990-04		Jere	Kaduna	V		
24	1990-06-27		Ibadan	Oyo	2.7(M1)	Closes to Ijebu- Ode	Buildings Vibrated
25	1994-11-07	05:07:51	Ijebu-Ode, Dan Gulbi	Ogun, Zamfara	4.2(M1)	Dan Gulbi	Cracks in the buildings
26	1997		Okitipapa	Ekiti`	iv	Close Okitipapa bridge	
27	2000-03-07	15:53:54	Ibadan, Oyo, Akure, Okitipapa, Abeokuta, Ijebu-ode, Shagamu	Oyo, Ekiti, Ogun	4.5(Ml)	Close To Okitipapa	
28	2000-03-13	15:53:54	Benin	Edo	iv	Benin City (55km From Benin	
29	2000-05-07	11:00	Akure	Ondo	iv	Close to Okitipapa	Ground Shaking
30	2001-05-19		Lagos	Lagos	iv	Close to Lagos City	
31	2002-08-08		Lagos	Lagos	iv	Lagos City	
32	2000-08-15		Jushi-Kwari	Kaduna	iii	Close To JushiKwari Village	
33	2005-03		Yola	Adamawa	iii	Close To Cameroun volcanic line	
34	2006-03-25	11:20	Lumpa	Niger	iii	Close to IfewaraZungeru falls	
35	2009		Saki	Oyo	iii-iv		
36	2009		Abeokuta	Ogun			
37	2011-11-05		Abeokuta	Ogun	4.4m	Close to Abeokuta	
38	2016-09-12	Kwol,	Kwoi border communities between Bayesal and Rivers (Igbogene)	Kaduna, Rivers, Bayesal	2.6. 3.0 M		Damage to structures
39	2018-09-05 to 08	Mpape	Abuja	ii-iv			No cracks, Magma likes substance coming out soil

The b-value for Nigeria is 0.99 and this implies that the seismotectonic setting of Nigeria is that of an Intraplate (within the tectonic plates not at the ridges or edges).

Methods used in the design and construction of buildings resilient to earthquakes

There are various ways a building can be protected from seismic waves or earthquakes using principles in architecture and engineering (A Chaleson, 2012). Therefore eight different priciples and methods were extracted for the purpose of this research;

1. Eccentricity of Building Forms
2. Rubber/friction Base Isolation
3. Buckle Resistant Braces
4. Pagoda Method
5. Hendison system
6. Construction of Basement floors
7. Tuned Mass Damper
8. Buffer system that uses water or gas reduce friction

These principles have proven to be effective in countries like Japan that had an average of 1,600 earthquakes in 2011 only (Ohto et al, 2015). Each method is used for certain reasons either of building height, type of structural system of the building.

METHODOLOGY

The method of research used to carry out this study was qualitative research methods, where primary and secondary forms of data was collected through interviews, observations, publications, internet extracts and from professionals in the built environment. The non-probability sampling technique was applied to determine if there is a need for developing standards for the design and construction of buildings along fault lines and earthquake prone areas, using the convenience method of Sampling. Tools implored were the use of in-depth indirect interview, conducted as the major tool in this research. However, content analysis and observations were also applied.

RESULTS AND DISCUSSIONS

The results from this exercise were presented in percentage of those in agreement either strongly agree, agreed or disagreed. The major question asked was, if they agree that Nigerian institutions needs to carryout serious studies to identify all fault lines within the country and Abuja to develop standards for the Architectural and Engineering Construction industry to design and construct buildings along these zones? The results retrieved from seven (7) institutions both federal and private were:

Table 2; interview results

Agency/Institute	Strogly Agree	Agree	Disagree
F H A (Federal Housing Authority)	25	75	-
N E M A (National Emergency Management Agency)	90	10	-
N G S A (National Geological Survey Agency)	80	20	-
F C D A (Federal Capital Development Authority)	72	28	-
DDC (Department of Development Control AMMAC)	100	-	-
N I A (Nigerian Institute of Architects)	95	5	-
N S E (Nigerian Society of Engineers)	100	-	-

Source: Field data

This result shows that most seem to be in strong agreement to the development of standards by the federal government agencies for design and construction of buildings resilient to earthquake. Very few are in agreement to this and non are in disagreement.

From the interviews conducted the professionals in the professional institutes where more informed of the occurrence of earth tremor in Abuja and environment and mentioned that it is necessary for a country like Nigeria to plan for the unexpected. The government agencies are ready to enforce the standards once passed by the government.

CONCLUSION

It was recommended that professionals in the built environment as well as the federal government agencies should come together to retrieve more accurate data of the transitional pattern of the seismic waves and tectonic movement in Abuja, so as to arrive at a more recent data. Having these parameters will help guide decisions and plan for an effective Standards and policies that will be used for building design and construction development in areas marked along the seismic fault line.

In conclusion, the study has been able to show that there is a high need for the development of standards for earthquake resilience in Abuja. This will help reduce the degree of loss of lives and properties to the barest minimum and the buildings will translate the culture and heritage of Abuja for a long time without an effect of earthquake that results to a collapse of the structure.

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Behaviour and Functioning of Children Hospitalized in Nigerian Conventional Hospital Ward Setting

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Abstract:
For hospitalized children, stress is a constant. Studies in the last two decades has shown that hospital norms, medical protocols and situational cues stress children's lives and delays their health restoration. The aim of this study is to explore the behavioural responses of children in hospital wards without intervention measures in northern Nigeria. Features and attributes in the ward that can sustain children's interest, physically, socially and cognitively are lacking. This study methodological approach uses observation and judgemental scale questionnaire on how illness and hospitalization define children's behaviour in relation to their healthcare settings. The study was conducted at Abubakar Tafawa Balewa University Teaching hospital Bauchi Nigeria. A total of 12 children were observed for 2 weeks and 15 nurses responded to the Analytical Hierarchy process (AHP) scale questionnaire respectively. The hermeneutic analysis of recorded videos and Expert Choice were categorized to relate with the domains of physical, social and cognitive activities. Action and behaviour shown by the children are physical behaviour (n=7), followed by social behaviour (n=4) and cognitive behaviour (n=4). Findings from Expert Choice (EC) revealed that children behaved regressively in the ward, they display more passive behaviour than active behaviour in the ward with being fearful and restlessness scoring the highest. It signified that the children were experiencing low physical, social and cognitive functioning. The result of the study indicated an association between hospital norms, medical protocols with situational cues and their effect on children's behavioural outcomes. Even if the present understanding of the hospital norms and protocol is being considered favourable in caring for ill children, the study showed it hinders their restoration process.

***Keywords**: Children, Hospitalization, Hospital norms, Medical protocols, Situational cues, Health restoration*

INTRODUCTION

Situational cues are rarely used in phenomenological study on person-environment transaction of children in their hospital ward setting. Studies have revealed that children's hospitalization interrupts a child's usual routine by leaving their familiar environments (Frumkin, 2001; Roberts, 2010; Wilson et al., 2010). Example, from playgrounds, school and home, to an unfamiliar hospital setting with a number of other features and situations that can result into negative psychological and emotional state (DeMaso and Snell, 2013; Lerwick, 2013; Wilson et al., 2010). As such, the children exhibit passive behaviour such as, feeling of anxiety, boredom, anger, sadness, and worry as well as being isolated from peers, thus affording stress (Colwell et al., 2013; Livesley and Long, 2013; Adams et al., 2010; Pelander et al., 2007). The degree of the stress mainly depends on the physical setting and the cultural norms with medical protocols of the hospital (Whittaker and Chee, 2015). In this research context, children lack the freedom to independently move around, play and interact in the hospital wards (Coyne, 2006; Weaver and Groves, 2003). This is due to over stretched hospital ward facilities such as beds that covers more space and brings children to stay closely with strangers (Redshaw, 2002).

The lack of activities has also been attributed to other factors that includes individual differences and demographic factors relating to age and gender, where girls are found to have less autonomous mobility than boys (Pacilli et al., 2013). Place experience depending on child's familiarity with features found in their places (Brooks and Sorin, 2011; Castonguay, 2010). In addition, children place preference and attitudes towards place activities also differ from one child to another (Alexander et al., 2015). Furthermore, physical factors such as design and

quality of their environment, as well as lack of facilities and accessibility to play elements also hinder the child's functioning and positive behaviour (Czalczynska-Podolska, 2014). Therefore, lack of functional play elements and features in a setting for children deprived them proper functioning (Maier et al., 2009; Prieske et al., 2015).

It indicates that there is a mismatch between the situational cues in the ward setting and the children's needs. Meaning that, for the past 20 years the children behaved regressively, displaying negative behaviours such as fear, discomfort, anxiety, boredom, crying, and clinging to their parents (Lansdown, 1996; Lau, 2002; Moore et al., 2015; Wilson et al., 2010). As a result, the children's functioning, particularly their physical actions, social interactions and cognition are reduced. Thus, negatively influencing children restoration process (Eisen, 2006; Gouin and Kiecolt-Glaser, 2011). This phenomenon is common in many children's hospital wards in north eastern Nigeria. Presently, the hospital for children emphasises on the provision of medical equipment and facilities that added functionality to some extent. The psychological aspect of the cure is rather inefficient in supporting the process of children restoration (Eke et al., 2014). This is common because the design of hospital from pre-colonization era from 1902 to date are still reflecting on early European concepts of designs that are meant to provide care for illness, reduce infection and house medical equipment (Ulrich, 2002).

In addition, the arrangement of hospital ward space in this research context allows for 6 or more beds in a cubicle, as such the children do not have space that will allow them to play. Moreover, there is no provision of features such as toys that supports the play needs of children (Adeyemi and Oyewole, 2012). Gardens play provision and other landscaping features used in advanced countries to meet children preference are often not sustainable due to minimal rainfall, harsh weather, and in most cases it non-existent. By and large, the researcher being from the field of architecture is keen to explore the behavioural responses of children in hospital wards without intervention measures that can sustain their interest, physically, socially and cognitively. Studies by architects in healthcare setting has focused more on privacy, impact of facilities on wellbeing, safety, sustainability, ventilation, flexibility, innovations and so forth (Mourshed and Zhao, 2012; Reiling et al., 2008; Verderber et al., 2014). However, such studies are centred on form and function in relation to geometric relationships, thermal comfort which may not bother children functioning in most cases. For an overview of information gathered from public paediatric wards in Nigeria from 2013-2014, it indicates that almost all the wards lack intervention strategies that can assist children to cope with psychological and emotional stress of hospitalization.

METHOD

The behaviour of children in a hospital context is being elicited using video recording of children's activities and a judgmental scale questionnaire for caregivers using analytical hierarchy process (AHP). To elicit data on children passive behaviour and to ascertain which of the behaviour are most dominant in the ward without intervention measures that can sustain children's interest. The data obtained from both qualitative and quantitative processes were analysed separately using content analysis and Expert Choice II. Findings from each method where triangulated to obtain the reliability of the results which can be used in a broader sense, alongside other research that explores on the psychological benefits of play experience to hospitalized children. The methodology used in carrying out this research was tailored towards answering the study objective. Basically the research design was concentrated on identifying the passive behaviour of children in a hospital ward in the Nigerian context

Background and unit analysis

The unit of analysis of this study are children of early and middle childhood (n=12), aged 3 years to 12 years old. Children recruited for this study were admitted to recover from illness and diseases, such as sickle cells, typhoid and malaria fever. Th children hospital ward of Abubakar Tafawa Balewa University teaching Hospital Bauchi was choosen for this study because; it is one of the 18th Teaching Hospitals of the Federal Government; It has 700-bed capacity with different generation of infrastructure from 1981; The hospital offers full services involving healthcare services, training and research; An average of 3400 patients are seen for different diagnosis from neighbouring state and districts per week

Approach for data collection

The study uses pragmatist-phenomelogical approach to ascertain person-environment transaction and children's adaptation, coping abilities, relationship with other patients and their caregivers. Thus, the study measures the result of events by interpreting the activities of children in a context (Goldstein, 2012). Pragmatist-phenomenology is employed in this study to straighten the mixed method adopted with qualitative approach as main domain which involves exploring and describing situated freedom actions of hospitalized children in a hospital ward (Lopez and Willis, 2004). Study by Walsh et al, (2010) emphasise that phenomenology examines and interprets human, in relation to their contextual situations, events, meaning and experience. The study of children in a ward setting entails observing children situated actions as it freely and naturally occurs in the course of everyday existence

Measurement of strategy using video recording

Many studies have used video recording to observe phenomenological behaviour in a context. For example, study in paediatric setting by Green et al, (2015) uses web-camera to view hospitalized infants effect on their parental stress, anxiety and bonding. Likewise, Türk et al, (2013) uses a video camera to record children post-surgical follow up to observe on their reduction in fear and anxiety during the time they spend in their waiting room. This study equally employed the use of video recording of children's behaviours and functioning. The data collection process was carried out with digital video recorder, hidden to elicit covert data on children's behaviour. Wordings of children were elicited during their interaction with doctors, nurses, parents and other children in the ward. The purpose of using the video recording is to understand children's behaviour and their preference of a hospital ward setting. The observation provides an insight on children situated freedom, communication and relationship with their caregivers.

Measurement of strategy using AHP questionnaire

Analytical Hierarchy Process (AHP) is a multi-criteria decision making approach originated by Saaty (2008). It has been applied in group decision in related field of study like education and healthcare (Murat et al., 2015). It allows for a structure that represents and quantifies properties and attributes in relation to the overall objective. Contextual conditions of hospital ward settings with norms and protocols that affect children's behaviour were elicited via their caregivers using judgement scaled questionnaires. It is a method used to derive ratio scale from paired measurement involving subjective opinion, such as feelings and preference (Koczkodaj et al., 2014). This is to judge which entity has a higher influence and quantitative properties (Cuadrado et al., 2015). Perceptual judgement of children's behaviour associated with hospitalization.

STUDY SITE

The study was carried out at Abubakar Tafawa Balewa University teaching hospital in Bauchi, Nigeria. It was formally a specialist hospital upgraded to a teaching hospital in 2010, being the

18th teaching hospital of the federal government. It has 700-bed capacity with different generations of infrastructure from 1918 that render health services to the populace. The hospital offers full services involving healthcare services, training and research. Being the major health facility in the state with a population of 4.6 million people it also serves patients from the neighbouring states. The hospital is the second teaching hospital in the Northeast geopolitical zone, which has a population of about 19 million. There is a high turnover of patients at an average of 3,400 patients is seen per week with a percentage bed occupancy rate of 72.8% for inpatient. Copyright ©2014 Abubakar Tafawa Balewa University Teaching Hospital, Bauchi. All rights reserved', (2016).

ETHICAL CLEARANCE

Approval for the study was issued by the ethical and research committee of Abubakar Tafawa Balewa University Teaching Hospital Bauchi to conduct research with children. The hospital ethics committee instructed the researcher to register for a free course with Collaborative Institutional Training Initiative (CITI). That offers training and learning about human subject research in collaboration with the West African bioethics training programme, and the researcher was instructed to take courses in the following modules; (i) history and ethical principles, (ii) defining research with human subjects, (iii) regulations, (iv) assessing risk, (v) informed consent, (vi) privacy and confidentiality, (vii) research with children and (viii) conflict in research involving human subjects. Furthermore, the researcher had a session with parents and caregiver's, adding that participating is voluntary and they can withdraw their children from the study at any time. At the same time, written information on the nature of the study and consent forms in English and Hausa language were produced to obtain their approval. The forms were important requirement in conducting research with hospitalized children (Kassam-Adams Elana, 2002). The parents and guardians were required to consent on their child's participation.

RESULT AND DISCUSSION

The physical settings in Nigerian children's wards lacks certain basic artifact and attributes that could contribute to the children movement and activities. This is because the ward from design stage to occupation gives less emphasis on issues that relates to children psychological and physiological health outcome. Meaning that, the concentration is on the housing of medical equipment and apparatus. The ward design is centred on policies and architect's views, without considering children preference and needs which include places for their play. The result from the analysis of recorded videos for 15 minute intervals identified the ward featuress and attributes that influence child regressive behaviour as shown in Table 1. The results were categorized to relate with the domains of physical, social and cognitive activities (Demetriou et al., 2015). The results were based on children's actions and behaviour in the hospital ward settings. Action and behaviour shown by the children are physical behaviour (n=7), followed by social behaviour (n=4) and cognitive behaviour (n=4). The outcome of this activity and behaviour contributed to children's regressive behaviour such as crying, being bored and fearful. The result shows the actions and behaviour of children in the dominant ward setting are as a result of cause and effect of the properties and attributes in the ward (Patti et al., 2013).

Table 1: Classification of children's behaviour in controlled ward cubicle

S/N	Observed behaviour	Themes	Domain
1	Staying quiet Creeping on the bed Hiding face Scratching Nails biting Teeth grinding Moving slowly (n=7)	Sedentary in their bed Being weak	Physical Functioning
2	Needing adult support Surrogate stimulation Nodding their head in response to caregivers Self play with hand phone (n=5)	Not interacting with peers Clinging to parents	Social Functioning
3	Thumb soaking Non-cooperating Frowning Open mouth (n=4)	Excessive crying Excessive fear Boredom Restless Discomfort	Cognitive Functioning

Social functioning

Results in Table 1 reveal four social behaviour and actions in the hospital ward cubicle. The actions and behaviours were normally performed by children on their beds, they included needing adults support, nodding head, watching a play from far and playing alone. They engaged in these activities and behaviour because they lack space to interact and relate with others in the ward (Rapoport, 2014). Needing adults support means that the children relied on their parents and caregivers for physical and emotional support in the ward. The result indicated that children receive support from their parents and caregivers through friendly interaction, communication and caring facial expression to the children (Duzkaya et al., 2014). The support included helping a child to adjust his headrest, feeding, rubbing and placing ice block on swollen arm due to injection and cannula or when they needed to take their bath (Foglia and Milonovich, 2011). Inasmuch, as this finding is peculiar to Nigerian context, caregiving in developed nations such as the United States of America are being provided by the caregivers. For example, a caregiver is responsible for placing a child's hand on a heating pad or when there is the need to change and clean them (Roberts, 2010), however, this is not available in Nigeria.

Furthermore, children's social performance in the ward included nodding. This means that they agreed on taking their medication. This finding affirms with studies in infant's behaviour and development by (Fusaro et al., 2014) found that children used to nod in indicating their self-assurance. However, studies by Kim et al, (2014) suggests that nodding is as a result of low self-esteem, social distress and social anxiety as the reason children use nodded in communicating with the nurses and their parents in the ward. This suggests that the children nod their head in approval, which to some extend further straighten their relationship with caregivers in the ward.

Cognitive functioning

The result reveals four actions and behaviours in the hospital ward cubicle that demonstrated children cognitive performance. The behaviour was performed on their bed either lying down and sometimes when they were seated. These behaviours included thumb sucking, non-

cooperating to medication, frowning of their faces and opening their mouth. Thumb sucking is an inappropriate habit, reluctantly done by children, mostly using right hand to comfort themselves (Hepper et al., 2005). This implies that children suck their thumb because they lack incitement from the ward that will motivate and enhance their functioning. This also suggests that the children were using their thumb to relieve themselves from the ward conditions that causes them to behave regressively. It means that the children were helpless in the ward that created a discrepancy between the demand of their situation and the cognitive resources available to them as children (Liaw et al., 2011; Monteiro et al., 2014).

Treatment and medication in the ward. It means that the children do not relate well with the nurses when giving them drugs, injection, taking their blood sample, and when replacing cannula. The results further show that children frown their face whenever there was a nurse presence at their bedside or in their ward cubicle. This finding suggests that the children were scared of the nurses. The children's perception was that they were responsible for inflicting more pain in addition to their illness. In paediatric nursing, Albert et al, (2013) also found that the nurses white colour uniform scared the children's which resulted to their negative emotions.The results further showed that the children in the ward like to leave their mouth wide open for a long period of time. This behaviour was noticed to occur when the children are lying idle on their bed. This means that the children were restless with nothing to motivate them and keep them occupied. This implies that there are no provisions for play items to see, feel and grab to regain their cognitive functioning in the control hospital ward. In the context of cognitive behaviour, (Flessner, 2011) found that open mouth relates to unoccupied mind, with lack of physical and social integration that would improve on patients cognitive functioning.

Triangulating the result with findings from the Analytical Hierarchy Process (AHP) analysis with caregivers (n=15) with the form video recording, it consistently revealed that children behaved regressively in the ward cubicle. It was found that children display more passive behaviour than active behaviour in the control ward cubicles with fear and restless as the highest. It means that the regressive behaviour signified that the children were experiencing low, physical, social and cognitive functioning. Figure 1indicated the ranking of children's regressive behaviour observed by their caregivers in the ward.

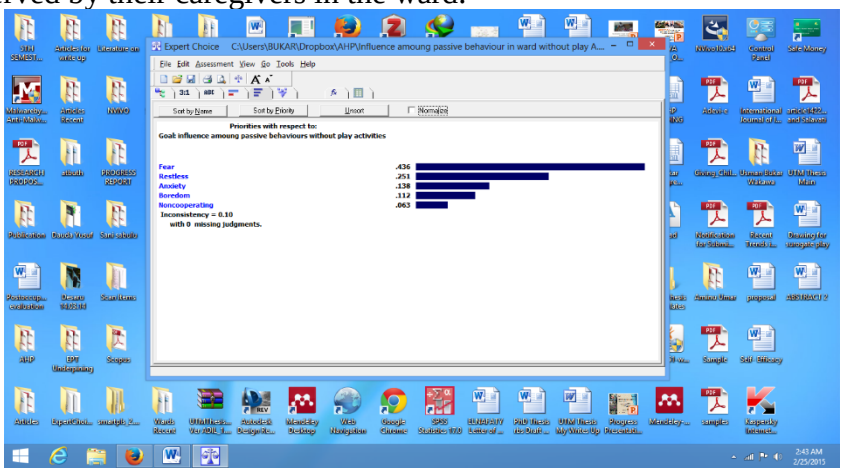

Figure 1: Ranking of children's behaviour in the control ward cubicle

The findings on the regressive behaviours which included being fearful, restlessness, anxiety, boredom and non-cooperative were consistent with findings in landscape architecture by (Said, 2006). It is also in line with paediatric nursing studies by Lau (2002) and Lindheim et al, (1972). These behaviours were due to fear of medical procedures and pains as well as unfavourable ward properties. This is synonymous with the literature in pain management nursing by (Foster

and Park, 2012) which stated that fear and anxiety are among the most reported stresses that contribute to children slow recovery. The slow recovery means prolonged hospital stay, experiencing pain and increased the use of more sedatives. This suggests that lack of intervention such as play items and space for children's movement and interaction makes them to behave regressively.

CONCLUSIONS

The hospital paediatric ward can be noisy, unfriendly, and uncomfortable. Most of the time, it is filled with beds and chairs. The walls are plain, the floors are bare and it is crowded with people, which at a glance looks like the children are confined in a cage. Despite the medical apparatus, illnesses and protocols, being in an unfamiliar setting with strangers and limited space for movement are a major contributing factor for stress to the children. As the ward being examined children were seen to show regressive emotional behaviours signs such as boredom, anxiety and clinging to their parents. Even with the show of regressive behaviours, the nurses and doctors together with parents want to see the children in bed receiving treatment and being cared for in the ward. Even though this was the common practice in this research context, hospitalization is centred on medical norms and hospital protocols. It is important to know that children are different because they like to satisfy their inert play desires even when hospitalized. Even with their parents present, only few affordable interactions like caregiving, feeding and physical support prevails which seem not enough for the child's physical, social and cognitive needs. At times, parents were seen bored as well in the ward and thus the children at times indulge themselves in their own ways of playing such as having hand phones at their disposals. This scenario has forced the child to perceive the ward as a setting that lack features and situations that fits with their needs and demands.

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Indoor Occupancy Detection using Machine Learning Techniques

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***Abstract**:*
Indoor occupancy detection is one of the smart building areas that received a lot of research attention in the past years. Indoor occupancy detection serves various applications in building operations such as energy-saving, evacuation, indoor emergency, and safety check. Existing techniques use direct occupancy sensing to detect and predict room occupant which has a major drawback of inaccurate prediction. To address this challenge this study proposed an indoor occupancy detection model that uses machine learning artificial intelligent technique to estimate the number of occupancies based on an indoor environmental variable dataset from previous knowledge and performance. The key goal of this study is to compare the finding obtained by various algorithms, which include many variables such as True Positive, False Positive rate, and so on, to achieve optimum performance. The collected findings were mostly based on improving precision such that proper research could be performed on them, which could then be used for various purposes.

Keywords: Energy efficiency, Machine learning, occupancy, smart home

INTRODUCTION

As technology continues to make computing power and computer automation more available, there is a growing need for intelligent, connected systems (Aftab, Chen, Chau, & Rahwan, 2017). Consumers want programs that can predict their desires and react appropriately to make their lives easier (Aliero, Qureshi, Pasha, & Jeon, 2021).

To face this challenge, every smart machine must have adequate knowledge about what particular action is expected of it as well as the state of the world in which it must operate. This vital sense must be observed and evaluated in some manner before it can be considered by the method. Researchers are now focusing on specific smart building applications, such as smart homes and smart workplaces, crowd behavior monitoring, and human activity detection. Any of these implementations have one thing in common: they all need context regarding the users in the measurable environment (Danjuma, et al., 2020).

This meaning may be unique to per-person features such as the person's location, or it may explain the characteristics of spaces and how many people refer to that room. While some occupancy-capable systems perform well in some of these applications, developing a device that can generalize to a wide range of settings is difficult. The technology accessible to a big office building seeking smart office power differs significantly from that available to a smart house. The occupancy background should provide an estimate of the number of people present to support a broader spectrum of issues (Mahmoud, Ahmad, Mohd Yatim, & Dodo, 2020).

A WSN can be followed by machine learning (ML) models to solve the problem of domain-specific variation. These trained models, although capable and configurable, have a rather wide design space, necessitating a very different form of domain expertise (Syed Ahmed, Dodo, Nafida & Kamarulzaman, 2015). Since these frameworks are not readily constrained by the conventional design limitations of a WSN, it is critical to consider the influence of design decisions for learning-based occupancy systems to design a successful overall framework. This research is motivated by the need to gain this understanding

LITERATURE REVIEW

Occupancy identification and its application have been researched and implemented at different stages in the past, providing useful knowledge. This section provides a summary analysis of the existing technique presented in Table 1.lists the relevant work performed on occupancy prediction application in a smart building using different methods, techniques, and platforms (Aliero et al., 2021). The following terms are used in Table 1a, 1b and 1c to describe exiting solutions.

Reference- refers to the article reference citation
Approach –refers to the strategy proposed in the article
Hardware used- refers to the type of hardware used for prototype development
Technology –refers to the what technology employed for prototype deployment
Summary- refers to the summary of the proposed idea.

Table 1a: The Proposed Idea

Reference	Approach	Hardware used	Sensors	Technology	Summary
(Jin, Wang, Song, & Sun, 2018)	Room occupancy counting	LORA	Passive infrared, light, motion humidity, and temperature sensor	Internet of Thing technology and artificial neural network	The approach proposed people counting in an open office building that enables detection of people present in the office to control air condition energy consumption to maintain a satisfactory thermal comfort level. The model achieved 64% detection accuracy with high false reporting during weekends due to the report on light intensity.
(Jung & Jazizadeh, 2019)	Monitoring indoor environmental variable	LoRa transceiver	Carbon dioxide, Passive infrared, light, motion humidity, and temperature sensor	Internet of thing technology	The approach proposed a non-intrusive approach to people counting in the room through monitoring the assessment of the quality of the indoor environmental variable. The result of the experiment indicates using carbon dioxide to predict room occupancy is beneficial over the direct occupancy sensing approach. Similarly this approach support machine learning technique for the future improvement
(Aftab et al., 2017)	Building occupancy prediction	Arduino microcontroller	Passive infrared, light, motion, carbon dioxide, global thermometer, humidity, and temperature sensor	Internet of thing technology and machine learning technique using Hidden Makov approach	The study suggests that indoor smart people counting offers variable application includes energy saving, people evacuation, and safety in the building. The approach proposed a machine learning technique to predict occupancy present in the building based on their scheduled activities. The proposed approach show accuracy of over 85% when testing in the office building. However, such an approach might be prone to false alarms when testing in a commercial building where occupants' behavior is hard to predict since there is no specific schedule for entering and leaving the building.
(Meana-Llorián, González García, Pelayo G-Bustelo, Cueva Lovelle, & Garcia-Fernandez, 2017)	Building occupancy counting for ventilation control	Arduino microcontroller	Passive infrared, light, motion, carbon dioxide, global thermometer, humidity, and temperature sensor	Internet of Thing technology and machine learning using statistical correlation approach	Recently researchers discovered occupancy numbers have a greater impact on building energy efficiency the approach proposed a technique for occupancy counting using machine learning by measuring the indoor environmental variable. The estimated occupancy number is later passed to the fuzzy engine as a thermostat to adjust the ventilation setpoint according to the number of people in the room to ensure energy-saving efficiency and satisfactory thermal comfort level. The proposed approach proved to be efficient by providing 50% energy saving in comparison with the traditional thermostat.

Table 1b. Existing techniques for occupancy detection approaches

(Ren, Wu, Gu, & Hu, 2020)	Building indoor occupancy	Arduino microcontroller	Passive infrared, light, motion, carbon dioxide, global thermometer, humidity, and temperature sensor	Internet of Thing technology and machine learning technique using random forest	This study described the importance of carbon dioxide as the major indicator of room occupation. The study investigates the various machine learning techniques to choose among the candidate model with high indoor occupancy prediction.
(Yang et al., 2020)	Smart building occupancy estimation	Arduino microcontroller and Bluetooth	Carbon dioxide, Passive infrared, light, motion humidity, and temperature sensor	Internet of Things technology and principle component analysis	The study proposed an environmental variables assessment to assess indoor air quality to predict room occupation. Many of the existing techniques use visual analysis to detect occupants present in the room. The study shows the decline of visual occupancy detection due to privacy concerns. Therefore environmental variable assessment is one of the viable techniques for the future smart home.
(Zhu & Li, 2018)	Occupancy estimation analysis in a smart building.	Arduino microcontroller	Carbon dioxide, Passive infrared, light, motion humidity, and temperature sensor	Internet of Things technology linear regression analysis	Indoor ventilation is one of the technologies that received attention in building energy efficiency over the years. Occupancy detection research has played a major role in the advancement of smart building energy efficiency. This study explored various techniques that can be used to detect occupancy in the building to improve indoor ventilation energy consumption rate.
(Zhang, Wang, Zhong, & Ma, 2019)	Smart building occupancy prediction	Arduino microcontroller	Thermal camera	Internet of Things technology and machine learning classification	Thermal cameras are used to detect intruding objects into the area of interest. Recent studies indicate large-scale deployment of smart thermal cameras and their application is increasing across various sectors. The thermal camera can detect room occupancy even in the night scene. In this study, a machine learning classifier was developed to differentiate between various room occupancy.
(Maschi, Pinto, Meneguette, & Baldassin, 2018)	Indoor occupancy prediction using smart Sensing	Arduino uno microcontroller	Carbon dioxide, Passive infrared, light, motion humidity, and temperature sensor	Internet of Things technology and artificial neural network, linear regression and machine learning classifier	The study discussed the limitation of occupancy status detection (present or absent) and proposed different machine learning techniques to estimate the number of room occupancy which would be more appropriate to optimize energy-saving potential. The proposed approaches were evaluated against heating, ventilation, and air condition system and proven to be effective in energy saving by providing up to 25% energy saving potential.

Table 1c. Existing techniques for occupancy detection approaches

(Ren, Wu, Gu, & Hu, 2020)	Building indoor occupancy	Arduino microcontroller	Passive infrared, light, motion, carbon dioxide, global thermometer, humidity, and temperature sensor	Internet of Thing technology and machine learning technique using random forest	This study described the importance of carbon dioxide as the major indicator of room occupation. The study investigates the various machine learning techniques to choose among the candidate model with high indoor occupancy prediction.
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METHOD

The prototype implementation employed machine learning techniques using Weka applications. Weka has a large collection of visualization techniques for data mining and statistical modeling, with web-based applications for easy and transparent access to certain features. It includes methods for a variety of tasks, including grouping, data pre-processing, regression, clustering, association rules, and visualization. We will test different techniques on

our data set to see which model provides the most precision with the shortest amount of time (see Table 2).

Naive Bayes algorithm expects the existence of a certain feature during a class that is irrelevant to the presence of the other feature. It is an ML model which can be used for huge quantities of data (millions of data) (millions of data). It's useful for symbolic research (Chen & Zhou, 2020). Decision Trees can be visual by mapping requirements to behavior. It reflects the fact that such acts must be carried out only if some conditions are met. More than one 'or' condition may be used in the tabular type of circumstances and behavior. In this study, when discussing various classification algorithms, we discovered the accuracy of various algorithms based on various factors (Mahdavinejad et al., 2018). A confusion matrix is a machine learning method or tool for summarizing the results of a binary classifier. Classification consistency alone in AI can be misleading if there are an ambiguous set of expectations in each class or if the dataset contains several classes. Confusion matrices are one of the main components of ML that are used to envision important predictive investigation such as evaluation, particularity, exactness, and precision. This technique combines some nonstop strengths into several spans.

Random Forest is a managed learning classification calculation that can be used for all strategies as well as relapse. In general, it is often used for community problems (Pinter, Felde, Mosavi, Ghamisi, & Gloaguen, 2020).

Simple Logistic is a learning pattern equation that is applied to predict the probability of an observable variable. The definition of the objective variable is binary, implying that there are only two possible types. Confusion matrices are considered important ML because they have given a clear correlation of values (Lalmuanawma, Hussain, & Chhakchhuak, 2020).

In multi-class classification, a dataset is prepare based on a classifier on how well the model does with training data and use a classifier to classify the data set. It is breaking in this way. It is used to evaluate the dataset that is used for training and testing the display of an order model. Datasets, followed by some other parameters.

RESULT

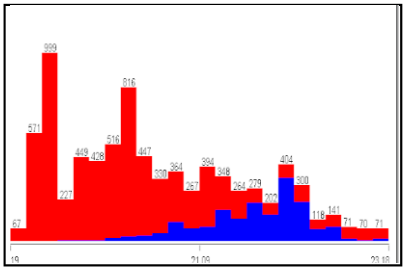
The data dataset and train model from indoor environmental variables is analyzed and presented in Table 2. The occupancy prediction from all algorithms employed shows high precision and other significant outcome variables for occupancy prediction. In addition, the test on datasets using statistical correlation analysis and results is computed using graphical presentation. The results show a strong correlation among environmental variables considered during room occupation and a weak correlation in the absence of the occupancy. Finally, Naive Bayes and Simple Logistic algorithms are considered to be the candidate model for occupancy detection with a precision of 88% followed by Random Forest with 84%.

True positive (TP) the sensitivity or memory of the procedure used to forecast real positives.
A false positive (FP) is a result in which the algorithm forecasts the positive class incorrectly.
Precision is applicable instances within the recovered instances is referred to as precision.
Recall is the percentage of the total number of significant instances that were currently recovered.

The F-measure is determined as the mean of precision and recall, with each given an equal score.

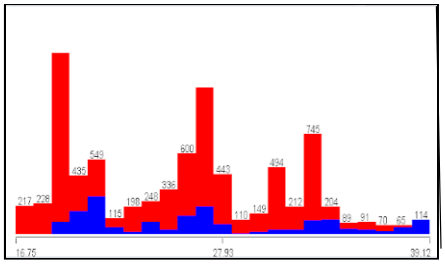
Table 2 result comparison of five different algorithms

S/N	Technique	Accuracy	TP Rate	FP Rate	Precision	Recall	F-Measure
1.	Naive Bayes	88.3%	0.883	0.011	0.883	0.883	0.883
2.	Decision Tree	62.5%	0.625	0.312	0.625	0.625	0.625
3.	Random Forest	84.8%	0.848	0.210	0.848	0.848	0.848
4.	Simple Logistic	88%	0.88	0.107	0.88	0.88	0.88
5.	Multi-Class Classifier	77.2%	0.772	0.164	0.772	0.772	0.772



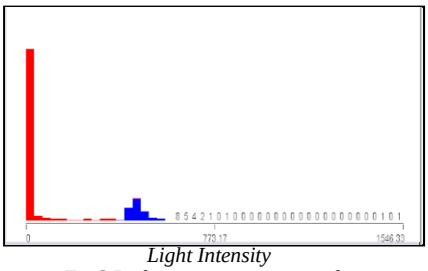
Temperature

Fig 1. Temperature count in relation to room occupation



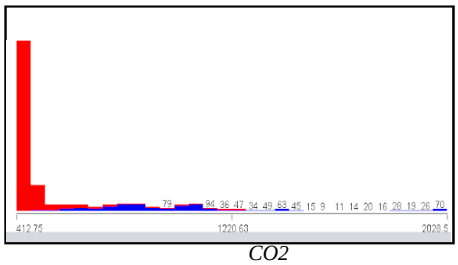
Humidity

Fig 2. Humidity count in relation with room occupation



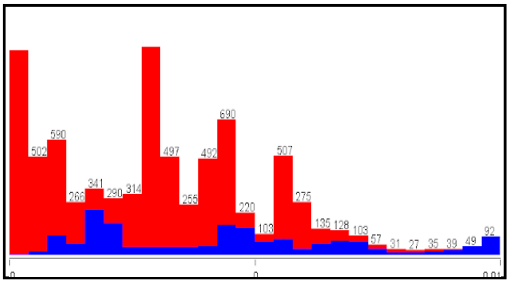
Light Intensity

Fig 3 Light intensity count in relation to room occupation



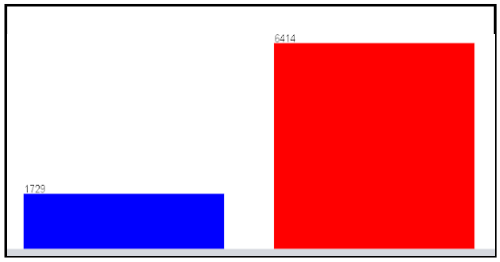
CO2

Fig 4. CO2 count in relation to room occupation



Humidity Ratio

Fig 5. Humidity Ratio count in relation with room occupancy



Occupancy

Fig 6. Occupancy ratio in the room

→ represent the absence of occupants

→ represent the presence of occupants

Detection of people inside a building is important to provide methods for detecting occupancy so it can be used for a variety of purposes. In today's technical landscape, detecting occupancy in automation networks for various purposes can be a critical task. It has enormous potential, especially in terms of regulating electricity equipment such as lighting, ventilation, and air

conditioning, which would be a tremendous application. Artificial Intelligence has a wide range of uses. Automation is one of them. It empowers any work to learn from and build on past experiences and outcomes without the need for specific programming. It focuses on the creation of a variety of other systems that can access data and use it to prepare and improve on their own by iterative methods before testing themselves. In this study occupancy detection based on machine learning algorithms was proposed using different techniques.

The data dataset and train model from indoor environmental variables is analyzed and presented in Table 2. The occupancy prediction from all algorithms employed shows high precision and other significant outcome variables for occupancy prediction. In addition, the test on datasets using statistical correlation analysis and results is computed using graphical presentation. The results show a strong correlation among environmental variables considered during room occupation and a weak correlation in the absence of the occupancy. Finally, Naive Bayes and Simple Logistic algorithms are considered to be the candidate model for occupancy detection with a precision of 88% followed by Random Forest with 84%.

CONCLUSION

This study outlines a method for identifying population designs in a closed space. A technique for discovering inhabitants is depicted, which is enhanced by data hypotheses and factual learning. The datasets of the occupants are examined using calculations such as Naive Bayes, structure by relapse, erratic backwoods, simple strategic, multiclass order, and preference tables. The analysis results show that Simple logistics has the highest accuracy presentation in capturing the elements of the room occupants of the six calculations, with an exactness of 88 percent. Such precision demonstrates the capacity for increasing structure energy efficiency and contributing to a greener environment. Future study will include gathering the requisite information from the sensor hub organization, but more importantly, investigating and using the collected data to streamline indoor temperature, all to save energy, heat, and electricity, but also to increase the welfare of members and tourists. From an exploration standpoint, a wider start to finish implementation analysis will be carried out, as the organization is progressed and improved to collect more facts or collaborate on other designs, such as actualizing our own AI classification measurement to increase the occupant discovery.

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Assessment of Factors Affecting Performance of Construction Organisations in Abuja, Nigeria

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Abstract:
The performance of organisations is often affected by lots of factors. These factors differ from one industry to the other; and the performance of construction organisation has a significant effect on the economy. It is a known fact that majority of construction organisations in Nigeria are not performing and this problem has led to delays in project delivery, failure in achieving effective time and cost performance, and poor-quality projects. This paper aimed to assess factors affecting the performance of construction organisation in Abuja with a view to improving performance of construction organisations. In achieving this aim, well-structured questionnaires were designed and distributed to two hundred respondents (200) in fifty (50) building and civil engineering construction organisations practising in Abuja, Nigeria. 186 questionnaires were retrieved and used for the analysis. Mean item score was used to calculate the factors according to their frequencies. The scores were ranked and it was found out that the factors that must be given importance to when planning on achieving better construction organisational performance were cash flows with MIS of 4.75, knowledge management with MIS of 3.75, and governance and economic policies with MIS of 3.75. The paper concluded from the output of the results that, construction organisations in Abuja should focus on knowledge management, cash flows, governance and economic policies, in order to achieve better construction organisational performance. The study recommends more focus on these factors to achieve a desired performance for construction organisations in Abuja, Nigeria.

Keywords*: Affecting, Construction, Factors, Organisations, Performance.*

INTRODUCTION

The performance of the organisations has been a problem to stake holders in the Nigerian construction industry (Babalola *et al.*, 2015). The rate at which these organisations are folding up or going out of business is alarming. For instance, in 2015 to 2018 alone more than fifty (50) of the construction companies in Abuja folded up, in which over twenty thousand (20,000) of the construction employees lost their jobs (Nigeria Economic Summit Group & Development 2018). This is a serious loss to the Nigerian economy which is just recovering from recession (Ezeh, 2013).

The alarming rate at which construction organisations' products deteriorate is a serious concern to all the stakeholders (Babalola *et al.*, 2015). Most of these problems are due to poor performance of these organisations. Performance of an organisation is affected by a lot of factors, these factors have a lot of influence on organisations' performance which cannot be neglected (Moulin, 2017). Factors that affect organisational performance differ from one industry to the other. The factors that affect organisational performance in the manufacturing industry or banking industry are different from those that affect organisational performance in construction industry Tripathi and Jha (2017). This is so because every industry has uniqueness that makes it different from the other industry. It has also been acknowledged by many authors and researchers that the construction industry has its uniqueness on its products and size. This paper aimed at assessing all the factors that have been highlighted by the previous authors and determines the factors that have more influence on construction organisation using Abuja construction organisations as a study with a view to improving performance of construction organisations.

Factors affecting construction organisational performance

Ahmad (2017); Tegan *et al*. (2014) grouped factors that affect construction organisational performance into two, internal and external factors. Internal factors were further divided into the contractor and consultant related factors (Tripathi and Jha, 2017). Internal factors are the factors that are within the reach and control of the management of organisations while external factors are the factors that are beyond the control of the management, they are the factors that is control by the environment in which the organisation find itself.

Contractor Related Internal Factors

Ezeh (2013), Yaghoobi and Haddadi (2016) and Yu *et a*l. (2017) highlighted the following as i. contractor related internal factors: Poor Planning and control techniques (knowledge management), Poor financial control on site (Cash flow), Lack of training on quality for staff (motivation), Lack of Management leadership, Lack of management commitment to continual quality improvement, Organization culture, High Level of competition, High number of competitors, Resource wastage on site, Lack of previous experience of contractor, Lack of technical and professional expertise and resources to perform task, Lack of education and training to drive the improvement process:

Cash flow

Cash flow problem is a situation where organisations do not have enough cash to pay for the running of their business. Cash flow is described in construction projects in two ways, the net receipt or net disbursement resulting from receipts; and disbursements occurring in the same period (Ezeh, 2013). Cash flow problems are the main cause of organisations' financial difficulties which subsequently affect both technical and management performance practices of the organisations. The problems associated with cash flow are: delay in settling of claims and agreeing of variations/day works, under valuations of performed works, clients' insolvency and delays in payments of approved valued works (Yu *et a*l., 2017). Cost factors are important in construction organisations performance by implication and it has a strong relationship with performance of construction organisations in Nigeria.

Organisational Culture (OC)

Scholars have defined OC as shared values and beliefs held by individuals that form the basis for patterns of behaviour in solving problems. Saunila (2016) argued that the core content of OC covers beliefs, values and assumptions held by individuals within organisations. In contrast, Ahmad (2017) opined organisational culture as a behaviour that determines how an organization grasps and reacts to the external and internal environments, thus embedding the reaction to the organisational environment in the definition of OC. Many attributes concerning OC emerge in the literature. It has been considered to guide individual communications within an organisation and to be a critical antecedent factor for the success of knowledge management initiatives (Saunila, 2016).

Leadership

Leadership is the prime factor affecting the success or failure of organisations *(*Bakotić, 2016). It is the process in which one individual exerts influence over others. Leadership is a process that enables a person to influence others to achieve a goal and directs an organisation to become rational and consistent (Ahmad, 2017).

In organisations where there is confidence in the leaders, employees will look towards the leaders for almost everything. During drastic change in times, employees will perceive leadership as supportive, concerned and committed to their welfare, while at the same time recognising that tough decisions need to be made (Moullin, 2017). True leadership states that leadership skills can be mastered by people who wish to become leaders. The two very important components of effective leadership are: One is belief and confidence in leadership,

which is an indicator of employee satisfaction in the organisation. The second is effective communication by the leadership in making the employees understand the business strategy, helping them understand and contribute to the achievement of the organisation's business objectives and sharing information about organisation with the employees for their benefit and guidance (Sigalas, 2015).

Motivation

Motivation is a catalyst to move individuals toward goals. Motivation is the processes that account for an individual's intensity, direction, and persistence of effort toward attaining a goal (Yuliansyah *et al*. 2017). Motivation may be defined more formally as a psychological or internal process initiated by some need, which leads to the activity which will satisfy that need, therefore motivational factors differ from person to person (Ahmad 2017). According to Abraham Maslow theory there are five levels of human needs which need to be fulfilled for individuals at work. According to this theory the needs are structured into a hierarchy which starts at the lowest level of need up to the highest level when the needs of the workers are fully met. A worker can be motivated by the opportunity of having the next need in the hierarchy satisfied (Ahmad 2017).

According to Yang and Lu (2013) there are two main factors of motivation: Contextual factors and Descriptive factors. Contextual factors are factors like salaries, working conditions, organisation strategy. Descriptive factors are threats, opportunities, competences, sense of belonging. Motivation factors that are affective and effective in one employee or in a group of employees may not be affective or effective in others. This is an area where study and feedback will have to be carried out when measuring organisational performance (Ahmad 2017).

Knowledge management

Knowledge management is a concept in which an organisation deliberately gathers, organises, shares and analyses its knowledge in terms of resources, documents and people skills (Yaghoobi and Haddadi, 2016). As a result of technology advancement the way we access and embodies information has changed; in the current scenario many organisations have knowledge management frameworks in place. Knowledge Management has become a treasurable business tool; its complexity is often vexing and as a field will still be under development for a long time to come. Knowledge management will be integrated into the basket of effective management tools. The objective of Knowledge Management is to build and exploit intellectual capital in an effective and profitable manner this is an important factor to note when measuring performance measurement (Tripathi and Jha, 2017).

Consultant Related Internal Factors

Mathew *et al*. (2013) and Gambo and Said (2014) identified the following factors as consultant related factors; Fraudulent practices and kickbacks, Inadequate project team capability. Poor Information and communication channels, Inadequate Early and continual client/consultant consultation by contractor, Project managers competence / experience, Lack of On-Site project manager/ supervisor/ clerk of works, employee commitment and understanding, coordination between designers and contractors, Poor Monitoring and feedback, team work among stakeholders. Some of the factors highlighted are explained briefly below;

Fraudulent practices

This has been found out by Mathew *et al.* (2013) as the most severe factors that affect performance of organisations in Nigeria. The problems associated with fraudulent practices in construction industry are; actions not taken for non-compliance with the terms and conditions of contract, double payment for same item, and substitution of specified item with used or inferior ones, payments made on cost not incurred, falsification of contract documents and given gratitude to induce a party in the contract (Mathew *et al.*, 2013).

Gambo and Said (2014) identified fraudulent practices in the construction industry as one of the main factors affecting organisational performance in Nigeria. Mathew *et al.* (2013) reported that fraudulent practices and kickbacks are the most severe factors causing poor performance of organisations in Nigeria. Gambo and Said (2014) acknowledged that all government-funded projects in developing countries are mostly political in nature; this invariably leads to poor cash flow and fraudulent practice. Fraudulent practice is seen as the intent to deceive through false representation of a matter or a fact.

External Factors

Ahmad (2017) and Tegan *et al*. (2014) identified the following factors as external factors that have effect on construction organisations' performance; Bad governance, Irregular economic decision by government, International relations, Macro-economic conditions, Political conditions/ Political unrest, Nature of construction environments, Socio-cultural conditions, Legal condition, Intense rivalry between companies, New entrants to the market, Supply power, Client power

Nature of the construction environment affects the technical performance of projects; this has become a major issue to stakeholders in the construction industry (Horta, 2016). The problems associated with the nature of construction environments are: harsh construction sites, civil commotion/disturbances, topography of the construction/working site, site's constraints and storage limitations, availability and supply of labour to the site, hostile political and economic environments (Saunila, 2016).

The problem of water pollution is also seen as an important factor affecting performance of organisation by Pekkola *et al.* (2016). The effects of the nature of construction/working environments have significant impact on both financial, technical and management practices of organisations (Ryan, 2018). Gambo *et al.* (2017) reported that the effects of environment on organisational performance have a cumulative impact on the quality of products and further divided it into permanent and temporary effects. The permanent effects comprised meteorological trends like storms, geological process like soil and strata characteristics and long term environmental trend like climate changes (Gambo *et al.*, 2017).

The temporary effects comprised chemical, biological and ecological effects as well as social and political conditions such as land use acts, development trends, regulations, social trends and public safety (Ryan 2018). The nature of construction/working environments affects not only the projects themselves but also the project sites, materials and equipment used to build the projects such as concrete, timber, clay, sand, gravel, steel (Silvi *et al*., 2015).

All the factors identified and highlighted above are adopted in this study.

METHODOLOGY

This research employed the survey approach through the use of well-structured questionnaires. The construction organisations considered for the research were civil and building organisations active and practicing in Abuja, Nigeria. The survey strategies approach provided a focus for this research with the efforts to address the research problems.

The quantitative method was used to examine the factors that affect construction organisational performance in Abuja, Nigeria. The targeted population for this study were management members of fifty (50) construction organisations practicing in Abuja, Nigeria. This were. randomly chosen by the use of simple random sampling techniques from the Federation of Construction industry (FOCI) directory. The respondents were professionals and non-professionals who were management members of these organisations. These management members were chosen using judgemental sampling techniques the sample frame for this study is the multinational and some national construction organisations practicing in Abuja who are into building, civil and heavy engineering works. It was found out that each organisation had

an average of five management members that were willing to fill the questionnaires as at the time of collection of data. This management staff are the head of units in the organisations. Using the formula in Glenn (2013) the number of questionnaires distributed were 200 and the number retrieved were 186; this gave a response rate of 93% and this was used for the analysis. The questionnaire survey was used in this research to get the views and opinions of the management staff on the factors that affect performance of their organisations. These questionnaires were close ended and structured questionnaires; the questionnaires were in two sections, section A and B section. Section A was profile and questions that related to the background of the respondents and organisations, while section B was the list of factors affecting construction organisations. These factors were scaled from 1 to 5 using the following scale; Very low = 1 low = 2, moderately low = 3 , High= 4 and very high= 5 (Likert scale). Descriptive methods that is; Mean Item Score (MIS) was used to determine the most frequent factors from the respondents.

RESULTS AND DISCUSSION

Table 1 shows the background of the respondents and the organisations.

Table 1: Profile of the respondents and organisations

Gender of the respondents	**Frequency**	**Percentage**
Male	109	58.60
Female	77	41.40
Total	186	100
Age of the respondent		
20 -29	43	23.11
30 – 39	67	36.02
40 – 49	56	30.11
Above 50	20	10.76
Total	186	100
Type of organisation		
Client	74	39.80
Contractor	65	35.00
Consultant	45	24.20
Others	2	1
Total	186	100
Year of organisation in practise		
1 – 5	36	19.36
6 - 10	45	24.19
11 - 20	54	29.03
20 - 30	34	18.28
above 30	17	9.14
Total	186	100
Staff strength		
0 – 50	23	12.37
51 – 100	36	19.40
101 – 200	37	19.89
201 – 500	50	26.85
500 and above	40	21.51
Total	186	100
Qualifications of the respondent		
OND	19	10.22
BSC/HND	80	43.01
MSC/MTECH/MBA	67	36.02
PHD	5	2.68
Others	15	8.07
Total	186	100

The respondents have more of male (58.60%) than female, also the client-based organisations which is 39.80% are more than contractor and consultant-based organisations. The organisations that have spent between 11 to 20 years in practice were more (29.03%). The organisations that have staff strength of 201 to 500 were also more (26.85%). This just confirms the previous studies that usually reported Nigerian construction industry as one of the employers of large labour force. The majority of the respondents were degrees and higher national diplomas graduates 43.01%. More information on respondents' background and construction organisations profile is as shown in Table 1.

In the collection of data, the factors were grouped into two categories, internal factors and external factors and internal factors were of two types, contractors and consultant related factors. Table 2 shows internal contractor related factors. The contractor related factors ranged from Poor Planning and control techniques (knowledge management) to Lack of education and training to drive the improvement process(motivation). Knowledge management and Poor financial control on site (Cash flow) were ranked first with mean rank of 3.75, while Lack of training on quality for staff (motivation) and lack of management leadership were closely followed with a mean ranking of 3.73.

This showed that for any construction organisation to perform adequately the management teams need to seriously focus on proper planning, training and leadership competencies. Lack of education and training to drive the improvement process was ranked 10th with an index score of 3.37. Looking at the index scores the difference between the factors ranked 1st and the one ranked 10 was 0.38 not up to 0.5 that shows that all these factors are very important in the performance of construction organisations. This finding is in line with the findings of Ahmad (2017) and Tegan *et al*. (2014) who have identified the factors above as the factors that affect organisational performance in their respective areas of studies.

Table 2: Internal factors that affect construction organisational performance (contractor related factors)

Contractor Related Factors	**MIS**	**Rank**
Poor Planning and control techniques (knowledge management)	3.75	1st
Poor financial control on site (Cash flow)	3.75	1st
Lack of training on quality for staff (motivation)	3.73	3rd
Lack of Management leadership	3.73	3rd
Lack of management commitment to continual quality improvement	3.73	5th
Organization culture	3.69	6th
High Level of competition	3.67	7th
High number of competitors	3.65	8th
Resource wastage on site	3.54	9th
Lack of previous experience of contractor	3.44	10th
Lack of technical and professional expertise and resources to perform task	3.40	11th
Lack of education and training to drive the improvement process	3.37	12th

In Table 3 which shows consultant related factors, Fraudulent practices and kickbacks were ranked 1st with mean index score of 4.75 while Inefficient team work among stakeholders was ranked 10th with a mean index score of 3.87. The mean index scores were also close to each other like contractor related factors. This also shows that all factors are not to be neglected, this was as recommended by Mathew *et al.* (2013).

Table 4 shows the last category of factors which is external factors. These factors were ranked from 1st to 11th. Bad governance was ranked 1st with mean index score of 4.38 while Irregular economic decision by government was ranked 2nd with mean index scores of 4.10. Client power

was ranked 11th with mean index scores of 3.37. This was in line with the finding of Gambo *et al.* (2017) that emphasised on the issue of bad governance and the significant effect on organisational performance.

Table 3: Internal factors affecting construction organisational performance (consultant related)

Consultant Related Factors	MIS	Rank
Fraudulent practices and kickbacks	4.75	1st
Inadequate project team capability	4.38	2nd
Poor Information and communication channels	4.25	3rd
Inadequate Early and continual client/consultant consultation by contractor	4.19	4th
Project managers competence / experience	4.10	5th
Lack of On-Site project manager/ supervisor/ clerk of works	4.06	6th
Lack of employee commitment and understanding	4.04	7th
Lack of coordination between designers and contractors	3.98	8th
Poor Monitoring and feedback	3.88	9th
Inefficient team work among stakeholders	3.87	10th

Table 4: External factors affecting construction organisational performance

EXTERNAL FACTORS	MIS	RANK
Bad governance	4.38	1st
Irregular economic decision by government	4.10	2nd
International relations	4.06	3rd
Macro-economic conditions	3.83	4th
Political conditions/ Political unrest	3.75	5th
Nature of construction environments	3.75	5th
Socio-cultural conditions	3.74	6th
Legal condition	3.73	7th
Intense rivalry between companies	3.65	8th
New entrants to the market	3.63	9th
Supply power	3.44	10th
Client power	3.37	11th

CONCLUSION AND RECOMMENDATIONS

The responsibility of achieving success in the implementation of a construction project largely depends on the organisation's performance. However, it has become a global trend that organisations are not performing to expectations of the clients that they serve and indeed many construction organisations have failed to performance adequately due to one factor or the other. Poor Planning and control techniques (knowledge management), Bad governance, and Fraudulent practices were the factors ranked highest in the analysis above.

From the output of the results, construction organisations in Abuja should focus on knowledge management, cash flows, governance and economic policies, in order to achieve better construction organisational performance. Also the study recommends focus on these factors by all the stakeholders so as to achieve a desired performance for construction organisations in Abuja Nigeria. Also adequate instruments must be put in place by government so as to fight corruption and kickbacks in construction industry.

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Project Managers' Performance on Sustainable Construction of Residential Estates in Abuja, Nigeria

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Abstract
Encouraged by the support given to the sustainability agenda globally by the United Nations, Nigeria along with many other countries is slowly focusing on achieving a sustainable built environment. This paper assessed the performance of project managers on sustainable construction of residential estates in Abuja, Nigeria by examining project managers' perception of their own competence, and the performance of project managers on the sustainable construction of residential estates. Data collected from 26 Project Managers using close-ended-design questionnaires were analyzed through descriptive statistical methods (Mean Score and Relative Importance Index). Historical project data was also obtained on 22 residential estate projects, and was analysed using Percentage analysis. Findings from data analysis revealed that Project Managers rated themselves high in ten competencies and moderate in six competencies that include Budgeting, Risk management, and Emotional intelligence. The competencies of Project Managers had the strongest influence on project quality performance. All three of the traditional 'iron triangle' of project performance indices (cost; quality; time) were highly influenced by technical competencies such as Budgeting and Procurement management. it was recommended that Project Managers participate in Continuing Professional Development (CPD) in order to hone their competencies in areas such as Budgeting, Risk management, and Emotional intelligence where some weakness has been identified in this study.
Keywords: construction, performance, project manager, residential and sustainability

INTRODUCTION

Nigeria, like many other countries globally is beginning to focus on achieving a sustainable built environment (Dimuna and Omatsone, 2010; Akande *et al.*, 2015). With the support given to the sustainability agenda by the United Nations, construction professionals have to work towards attaining a high level of satisfaction of occupants' safety and comfort within the constraints of the sustainable development (SD) agenda requirements. A globally accepted definition of sustainable development provided in the Brundtland Report is 'meeting the needs of the present without compromising the ability of future generations to meet their own needs' (WCED, 1987).

Sustainable development is now a major part of the mission statement of many global organisations, national institutions, corporate companies, states and localities (Kates *et al.*, 2005). Buildings play a major role in the degradation of the natural environment (Mora *et al.*, 2011), through the consumption of major amounts of energy, water, and land usage. The high percentage of non-renewable resources consumed by it makes the building industry one of the least sustainable industries (Edwards, 2010). The built environment accounts for 40% of waste and greenhouse gases generated (CIOB, 2004). Buildings use as much as 45% of generated energy for air-conditioning and heating (Reed *et al.*, 2011); one-sixth of the world's fresh water usage, and one-quarter of wood harvested (Emmanuel, 2004).

The NCI is bedevilled with poor design and construction that uses harmful and non-renewable materials (Abigo *et al.*, 2012), as well as non-adherence to building practices that result in functional, healthy, and fit-for-purpose buildings (Jiboye, 2012). Adejimi (2005) noted that

none of the building professionals in the NCI takes responsibility for unsustainable and unsatisfactory buildings. The project manager, who only coordinates the process of design and construction, is left in a frustrating position. This paper focuses on the competency and performance of the project manager at the construction stage; the aim is to assess the performance of project managers on sustainable construction of residential estates in Abuja, Nigeria, with a view to enhancing sustainability in mass housing delivery. As a means of achieving this aim, this paper examined: (i) project managers' perception of their competency, and (ii) project managers' performance on the sustainable construction of residential estate projects.

LITERATURE REVIEW

Sustainable Construction

Sustainable development and environmental protection have become a major focus for governments based on scientific evidence that existing buildings consume a high amount of energy and materials, while also releasing significant quantities of harmful greenhouse gases (Thilakaratne and Lew, 2011). Efforts to reduce the ecological footprint of the construction industry threw up green building during the green movement of the 1970s to 1980s (Retzlaff, 2010). The underlying principle has been to find alternatives to traditional construction; such new methods of construction must save energy and reduce environmental pollution. Accordingly, green building construction (GBC) is another way of describing sustainable construction (SC), which is an important means of reducing environmental pollution and improving quality of life (Tan *et al*., 2011). SC has been touted as a significant measure to mitigate the significant (and mostly negative) impacts of the building stock on the environment, society, and economy (Zuo and Zhao, 2014). The theoretical and practical aim of green building or sustainable construction is to design and construct buildings using recycled materials, less water, less energy, and resource efficient techniques (Olubunmi *et al*., 2016).

The success of SC projects is measured by a wide range of indicators primarily because of differences in cultural and climatic conditions across the globe. Sang *et al*. (2018) found through literature analysis that the various definitions of the key success indicators all aim at minimal destruction of the environmental system. The United Kingdom in 1990 established the first environmental certification system, the Building Research Establishment Environmental Assessment Method (BREEAM); it covered nine aspects: management, health, and comfort, energy, transportation, water, materials, land use and ecology, garbage, and pollution (Lee and Burnett, 2008). Globally, the most widely used evaluation system for sustainable construction is The Leadership in Energy & Environmental Design (LEED) rating system. LEED consists of seven systems and multiple indicators, namely sustainable building sites, water efficiency, energy and atmosphere, resources and materials, indoor air quality, innovations in design, and regional priority (Suzer, 2015). There are many similar evaluation systems such as the Comprehensive Assessment System for Built Environment Efficiency (CASBEE) in Japan, the German Sustainable Building Council (DGNB) in Germany, and the Building Environmental Assessment Method (BEAM) in Hong Kong.

Sustainable construction has been studied from different perspectives. Tabassi *et al*. (2016) studied project manager leadership in sustainable building projects and identified six groups of success indicators: energy efficiency, indoor environmental quality, sustainable site planning and management, materials and resources, water efficiency, and innovation. Mattoni *et al*. (2018) defined six macro-indicator groups (site, water, energy, comfort and safety, materials and outdoor quality) derived from a comparative study of various evaluation systems. The multiplicity of SC standards in China was studied by Ye *et al*. (2015) and revealed the existence

of 17 national and trade standards and more than 50 local standards. The results of Sang *et al*. (2018) demonstrated that Leadership and organization, Target management, and Emotional intelligence of project managers are important factors that affect SC performance.

Project Managers' Competence

A project manager, according to Zwikael and Smyrk (2011), is the person contractually responsible for meeting the project's output targets; within the construction industry, project managers initiate, plan, execute, monitor and close projects. The five key stages of project management in construction (initiating, planning, executing, monitoring and closing) involve a multiplicity of participants. Thus the primary role of project managers is coordinating construction activities by the different team members to ensure that they perform the right tasks at the proper time (Gido and Clements, 2012). Project managers must ensure that people involved with the design and construction process possess the appropriate knowledge and resources needed to accomplish their assigned tasks (Sutton, 2011).

Competence has been defined as "the ability of an individual, a team, or a company to mobilize and combine resources (i.e., knowledge, skills, and attitudes) in order to implement an activity in a situation" (Loufrani-Fedida and Missonier, 2015, p. 1121). Although project manager leadership competencies are critical factors of failure or success that can be used to assess project performance (Anantatmula, 2010; Nixon *et al*., 2012), this is an area in which limited research has been conducted (Anantatmula, 2010; Fung, 2014). Jabar *et al*. (2018) found that project managers on Malaysian industrialized building system (IBS) construction projects have to undertake extra roles which required additional competency as compared to the generic construction projects.

Quite a number of frameworks for the evaluation of competency can be identified in project management. Examples include the International Project Management Association (IPMA) 'Competence Baseline' and the 'Guide to the Project Management Body of Knowledge (PMBOK)', developed by the Project Management Institute (PMI, 2013). The Competence Baseline of IPMA classified 46 competency elements into contextual, behavioural, and technical groups of competencies. On the other hand, the PMBOK identified project management competences in ten knowledge areas (PMI, 2013). However these competency models do not reflect leadership competencies required to improve project performance (Hollenbeck *et al*., 2006).

Performance of Project Managers

Performance of projects in the construction industry has been measured in a variety of ways; compliance with cost, schedule and quality targets has been used traditionally (Meng, 2012). Although project management processes have a significant impact on project time and cost (Almahmoud *et al*., 2012), these metrics alone are no longer sufficient to assess project performance (Nixon *et al*., 2012). Project performance encompasses other dimensions such as quality performance and stakeholder satisfaction, which must be considered in order to fully measure project performance (Almahmoud *et al*., 2012; Yang *et al*, 2014; Berssaneti and Carvalho, 2015).

There is evidence of the influence of project managers' leadership competence on project performance; Ahmed and Anantatmula (2017) demonstrated that all five leadership competencies of project managers are significantly related to achievement of project performance in terms of schedule, cost, and quality as well as stakeholder satisfaction.

METHODOLOGY

This study adopted a quantitative research design approach which involved the use of questionnaires and historical project data. A structured questionnaire was designed in five

sections, using Likert-style response options. Data was collected through random questionnaire survey of 28 recently completed mass housing projects in Abuja; only 26 questionnaires however contained valid data. Historical project data on initial and final costs and completion times were obtained for 22 projects. The study was limited to construction professionals who are performing project management roles on mass housing projects. They may be registered Project Managers or registered members of allied professions such as Architecture, Building, Civil/Structural/Electrical Engineering and Quantity Surveying. It is believed that they have adequate knowledge about the state of project management practice in Nigeria and can answer the questions of this study. The questionnaire data was analysed using descriptive statistical method (Mean Score and Relative Importance Index), which allowed the ranking of competencies and performance of Project Managers. Historical project data was analysed using Percentage analysis.

RESULTS AND DISCUSSION

Respondent Demographics

A breakdown of the demographics of the data collected through questionnaire is provided in Table 1. Female respondents constituted just 11.5% of the sample. Male respondents thus dominated the questionnaire survey, and this meant that the results will unavoidably be skewed towards a male point of view. This is unavoidable, as it reflects the current reality of gender imbalance in construction industries the world over. It also shows that the Nigeria Construction Industry (NCI) is not an exception in this respect. Within the NCI, the job of Project Manager is often performed by people from diverse professional backgrounds. There appears to be no clear-cut legislation on who should perform project management roles on construction projects. Engineers were most plentiful in the sample (some 42.6%). This is probably because of the different specialisations such as civil, mechanical and electrical engineering that were simply grouped together as 'engineers'.

Table 4.1: Demographic analysis of questionnaire survey results

Demographic parameters		**Frequency**	**Percentage**
Gender	Female	3	11.5
	Male	23	88.5
Profession	Architect	4	15.4
	Builder	1	3.8
	Engineer	12	46.2
	Estate Surveyor	0	0.0
	Quantity Surveyor	5	19.2
	Other (specify)	4	15.4
Education	OND/NCE	0	0.0
	HND/B.Sc	16	61.5
	M.Sc	10	38.5
	Ph.D	0	0.0
Experience	Less than 5 yrs	10	38.5
	6 yrs – 15 yrs	8	30.8
	16 yrs – 25 yrs	5	19.2
	More than 25 yrs	3	11.5

The educational background of the respondents comprised mainly possession of higher national diplomas (HND) and bachelor degrees (B.Sc) in construction disciplines; some 61.5% of the sample fell into this group. The rest 38.5% comprised respondents who had obtained a second, more advanced degree. In this case, such respondents had obtained a masters degree. It was found that a little over two thirds of the study had worked for less than 16 years. 19.2%

of the respondents had worked for between 16 years and 25 years, while the rest 11.5% of the sample had worked for more than 25 years.

Perception of Project Managers' Competence

The results presented in Table 2 can be clearly delineated into two main groups of competencies, on the basis of MS and/or RII. The first group comprises competencies that respondents perceived themselves as being highly competent in, since the MSs were higher than 3.50. The ten competencies in this group were Interpersonal skill, Scoping, Integration, Quality management, Scheduling, Networking ability, Document and contract administration, Transformational leadership, Apparent sincerity and Procurement management. This group was dominated by technical competencies (4 out of 10).

The other group comprised 6 competencies in which respondents were only moderately competent, based on the observation that MS lay between 2.50 and 3.49. These six competencies included Budgeting, Risk management, Interpersonal influence, Emotional intelligence, Visioning and Social astuteness. There was no consensus among the respondents on any of the competencies. Consensus attainment is indicated by a situation where the sum of responses in the 'very high competence (VHC)' and 'high competence (HC)' categories are at least 70% of all responses. The highest level of agreement observed was 68% in the case of 'Scoping', which was a 'Conceptual' competence. The only technical competence where the level of agreement exceeded 60% was 'quality management'.

Table 4.2: Ranking of project managers' competencies

Competency group	Competency components	Mean Score	SD	RII	Rank	Level of agreement	Remark
Human	Interpersonal skill	3.68	1.38	0.71	1	68	No consensus
Conceptual	Scoping	3.64	1.08	0.70	2	64	No consensus
Conceptual	Integration	3.64	1.08	0.70	2	62	No consensus
Technical	Quality management	3.62	1.17	0.72	4	60	No consensus
Technical	Scheduling	3.58	1.33	0.72	5	58	No consensus
Political	Networking ability	3.58	1.27	0.72	6	58	No consensus
Technical	Document and contract administration	3.58	1.14	0.72	7	58	No consensus
Human	Transformational leadership	3.58	1.06	0.72	8	58	No consensus
Political	Apparent sincerity	3.54	1.17	0.71	9	58	No consensus
Technical	Procurement management	3.54	1.14	0.71	10	54	No consensus
Technical	Budgeting	3.42	1.14	0.68	11	50	No consensus
Technical	Risk management	3.35	1.20	0.67	12	50	No consensus
Political	Interpersonal influence	3.35	1.06	0.67	13	50	No consensus
Human	Emotional intelligence	3.31	1.05	0.66	14	50	No consensus
Conceptual	Visioning	3.31	0.93	0.66	15	35	No consensus
Political	Social astuteness	3.04	0.77	0.61	16	27	No consensus

Notes: MS = Mean Score; SD = Standard Deviation

Project Managers' Performance

Project managers' performance was measured using five (5) indices of construction projects against sixteen (16) project management (PM) competency components. The five (5) indices of construction projects were (i) Cost (ii) Dispute resolution (iii) Health and safety (iv) Quality and (v) Time. The paper employed a 3-item semantic scale to show level of influence ('3' for 'High Influence'; '2' for 'Moderate Influence'; '1' for 'Low Influence'). A score of 2.50 or higher is thus required to indicate high level of influence.

The results presented in Table 4.3 revealed that the three 'conceptual' competencies (Scoping, Integration and Visioning) have significant influence only on the cost, quality and time performance. The cost of projects was most strongly influenced by 'Scoping' competency (MS = 2.58); respondents did not believe that the abilities to scope, integrate and vision a residential housing estate project would significantly affect how the project performs in terms of (i) dispute resolution and (ii) health and safety. 'Human' competency (composed of Emotional intelligence, Interpersonal skill and Transformational leadership) had significant influence only on the health and safety, quality and time performance of residential housing estate projects. The implication of this is that the Interpersonal skill of project managers does not significantly affect the cost, dispute resolution, health and safety and time performance of projects. Emotional intelligence of project managers does not significantly affect the cost, dispute resolution, and health and safety performance of projects.

Table 4.3: Influence of 'Conceptual' competencies on project performance

Competency group	Competency components	Cost		Dispute resolution		Health and Safety		Quality		Time	
		MS	**SD**	**MS**	**SD**	**MS**	**SD**	**MS**	**SD**	**MS**	**SD**
Conceptual	Scoping	**2.58**	0.64	2.20	0.58	2.38	0.70	**2.65**	0.63	**2.62**	0.64
Conceptual	Integration	**2.50**	0.71	2.19	0.57	2.48	0.65	**2.68**	0.56	**2.62**	0.64
Conceptual	Visioning	**2.50**	0.65	2.27	0.60	2.27	0.72	**2.69**	0.55	**2.62**	0.70
Human	Emotional intelligence	2.12	0.71	2.31	0.74	2.46	0.65	**2.56**	0.65	**2.50**	0.72
Human	Interpersonal skill	2.35	0.75	2.27	0.72	2.31	0.62	**2.50**	0.71	2.46	0.71
Human	Transformational leadership	2.42	0.64	2.42	0.64	**2.62**	0.50	**2.73**	0.45	**2.54**	0.65
Political	Social astuteness	2.15	0.78	2.23	0.71	2.31	0.74	2.38	0.70	2.27	0.78
Political	Interpersonal influence	2.31	0.62	2.46	0.51	2.42	0.58	**2.62**	0.50	2.42	0.58
Political	Networking ability	2.35	0.56	2.38	0.64	2.42	0.58	2.42	0.58	2.42	0.58
Political	Apparent sincerity	2.42	0.70	2.27	0.60	2.48	0.59	**2.65**	0.63	2.46	0.71
Technical	Scheduling	**2.65**	0.56	2.32	0.63	**2.58**	0.58	**2.62**	0.70	**2.62**	0.57
Technical	Budgeting	**2.54**	0.65	2.19	0.63	2.38	0.57	**2.69**	0.47	**2.64**	0.57
Technical	Quality management	**2.50**	0.65	2.35	0.56	**2.50**	0.58	**2.77**	0.51	**2.54**	0.58
Technical	Document and contract administration	**2.58**	0.58	2.31	0.68	2.42	0.64	**2.58**	0.58	**2.54**	0.65
Technical	Risk management	2.40	0.71	2.35	0.63	2.46	0.51	**2.62**	0.50	2.35	0.69
Technical	Procurement management	**2.50**	0.71	2.23	0.65	2.42	0.64	**2.58**	0.58	**2.54**	0.58

Notes: MS = Mean Score; SD = Standard Deviation; **Bold face** type indicates significant MS values

Only two of the four (4) competencies under the 'Political' competency group exerted significant influence on the quality performance of projects only. These were Interpersonal influence, which had a MS of 2.62 and Apparent sincerity (MS = 2.65). It was interesting that the political competency of project managers has significant effect on only quality performance. This might indicate a belief in the pivotal position of quality in construction; it has the ability to affect all other performance indices.

The 'Technical' competency of project managers comprised Scheduling, Budgeting, Quality management, Document and contract administration, Risk management and Procurement management. Only dispute resolution performance of projects was uninfluenced by any of the

six 'technical' competencies. This result might not be totally unexpected. Researchers generally agree that project performance encompasses other dimensions such as quality performance and stakeholder satisfaction, which must be considered in order to fully measure project performance (Berssaneti and Carvalho, 2015). However project performance is commonly evaluated in terms of schedule, cost, quality (the traditional 'iron triangle') as well as stakeholder satisfaction (Ahmed and Anantatmula 2017); dispute resolution and health and safety are usually subsumed under stakeholder satisfaction. Risk management competency exerted significant influence on only performance of projects in term of quality. This might be an indication of the low level of familiarity with risk management by project managers.

Cost and Time Performance of Projects

Composite line charts were employed to show the variations in cost and time performance. To control for the effect of size of project, the gross floor area of the projects was included in each chart. The salient points observed in Fig. 4.1 include a small but noticeable improvement in the cost performance of projects as the size of the projects increase; the costs of larger projects thus tended to be closer to their initial planned costs. Project managers have apparently been able to complete projects at costs ranging between 0% and 30% higher than were initially planned.

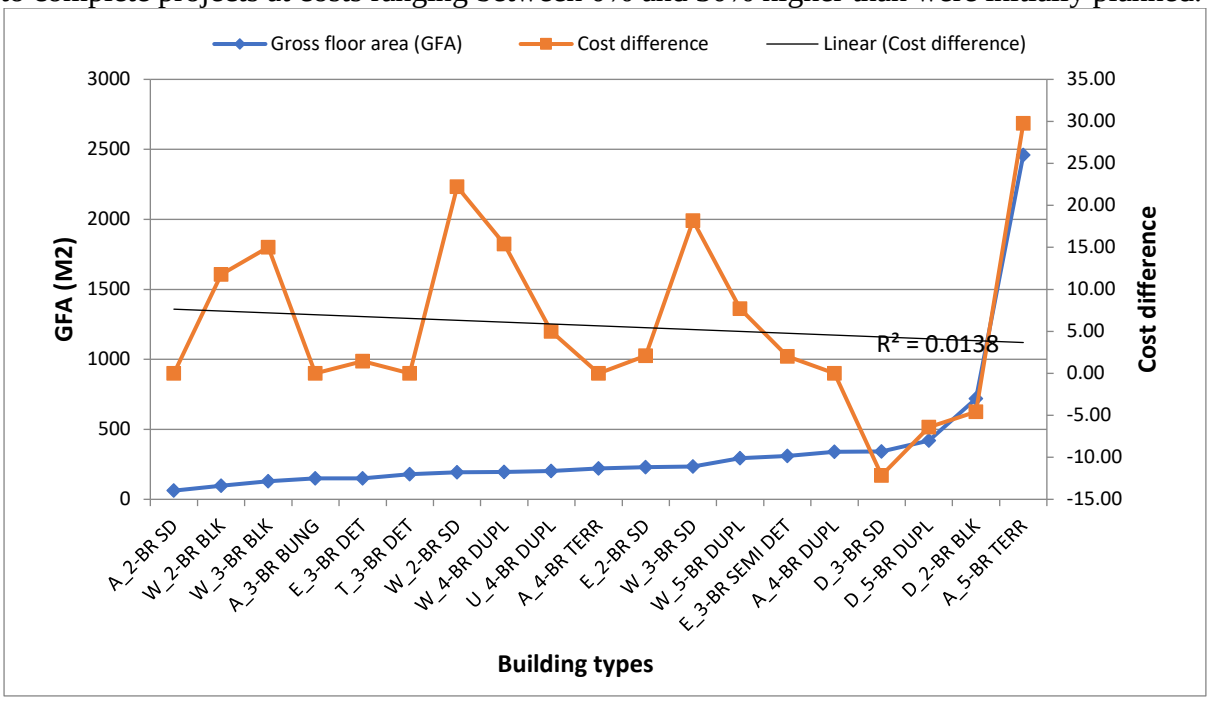

Fig. 4.1: Difference between initial and final costs

The time performance of projects, which was presented in Fig. 4.2, showed that projects were generally completed between 0% and 100% of their initially planned periods. The upward sloping trend line indicated that larger projects tended to be completed at longer periods than initially planned. These results reveal that time performance of residential housing estate projects should be an area of concern for project managers. Efforts need to be intensified to redress a situation where almost all projects take at least one-and-a-half times as long as planned to complete. The success of such efforts can also be expected to have positive impact on the cost performance of the projects, since there is a close relationship between project cost and time.

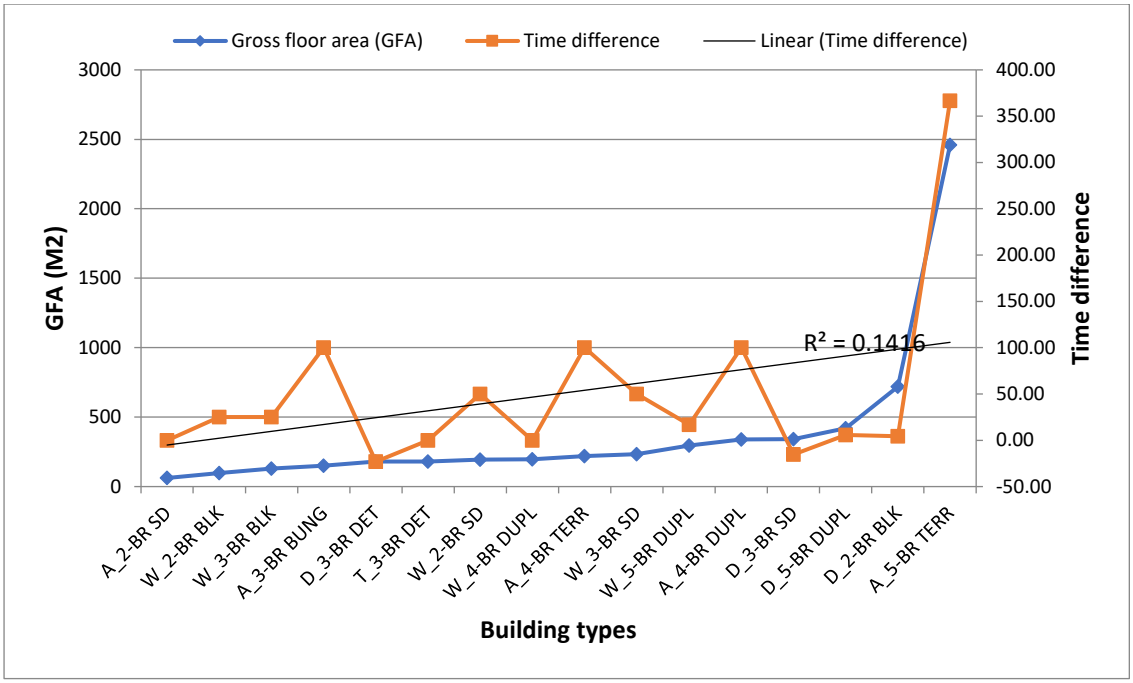

Fig. 4.2: Difference between initial and final time schedules

CONCLUSION

This paper assessed the performance of project managers on sustainable construction of residential estates developments. Using close-ended-design questionnaires, data was collected from 26 Project Managers (PMs); project cost data was obtained on 22 residential estate projects. The findings from analysis of data revealed that Project Managers rated themselves high in ten competencies and moderate in six competencies that include Budgeting, Risk management, and Emotional intelligence. All three of the traditional 'iron triangle' of project performance indices (cost; quality; time) were highly influenced by technical competencies such as Budgeting and Procurement management. It was inferred from the data that larger projects had better cost performance, but poorer schedule performance. Residential estate projects were generally completed at up to 30% higher than initial costs, and up to 100% of initially scheduled completion periods.

Based on the findings, it was recommended that Project Managers participate in Continuing Professional Development (CPD) in order to hone their competencies in areas such as Budgeting, Risk management, and Emotional intelligence where some weakness has been identified in this study. Project Managers should pay greater attention to managing project schedules, because significant unplanned extensions in completion times are bound to have some negative effect on the cost and quality performance of projects. This is an area where improvements in ability to apply soft competencies such as those in the Political category (Social astuteness, Interpersonal influence, Networking ability, and Apparent sincerity) will be useful.

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Residential Property Use Conversion and Rental Value Trends in Osogbo, Nigeria

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Abstract:

The volatility in property rental market and the increasing trend of property use conversions in Nigerian cities have become a typical issue of national discuss, as every available plots or building fronting Major Streets in our cities are either in the process of conversion or have been converted. This paper assesses property use conversions with the view to determining it causes and influence on rental trends or performances in Osogbo, the capital of Osun state. Ten years data on rental values spanning from 2010 to 2019 were collected and used for the study. Data on rental values and property usage were sourced from Estate Surveyors and Valuers (ESV) while information on use conversions were obtained from tenants and the State Ministry of Lands and Physical Planning (MLPP). In order to achieve the aim of the study, 236 questionnaires were administered on the respondents, only 200 questionnaires representing 84.75% was correctly filled and returned for analysis. Data collected were analyzed using both descriptive and inferential statistical techniques. The results of findings revealed a statistically significant influence of land/property use conversion factors on rental performances in the state. It further shows that economic and demographic factors are the two prime reasons for property use conversion from *residential to commercial uses, after use conversions command higher annual average rental values. The implications are among others, the creation of an unenviable property rental regime in the city and depletion of the available residential housing stock. It is on these findings that the study recommend the effective and efficient land use conversion control and management mechanism as well as incentive for residential property developers in the city of Osogbo.*

Keywords: *Residential Property, Property Use Conversions, Rental Values Trend.*

INTRODUCTION

Human settlements world over has and is steadily witnessing series of transformations due to global demographic explosion, technological advancement, socio-political influences and economic factors. Olarewaju (2016) observed that the current trend of global demographic pattern of expansion that ranges from progressive mega scale population increase to the micro level variation in the continental population distribution have implications on the existence and survival of cities. Advancement in modern day technology has drastically helped in the reduction of mortality rate globally, with increased birth rate, good living and longer life expectancy rate. Ankeli et al. (2019) reported that United Nations Population Funds put global population in 2011 at 7 billion which is currently above 7.3 billion. Cohen (2006) attributed the rapid urban growth resulting in stiff competition among nations for economic development of cities. Despite the advantages of the growth in economy, the management of the unprecedented population explosion, urban rental vitality, land use infiltrations and related issues have become one of the important challenges of our time.

Today, most cities are flashpoint zones for property use conversions in Nigeria. As a nation, Nigeria is said to be the harbinger and a nation at the frontend of the escalator of rapidly urbanizing nations' of the world, hence cities in the country are seen to be the centres of economic, political and social powers (Adegbola & Oluwale, 2018). However, Falade (2011) opined that cities and towns in Nigeria are completely different from what they used to be in the last fifty years due to the raising population and urbanization rate which have been fast tracked. The nations' population figure was said to be about 30 million in 1952 but by 2006, it increased to 140 million and was projected to reach 167 million by 2011 (National Population Commission 2006). Currently, the nations' population is said to be over 200 million people

with escalating urban growth rate from 7% in 1930 to 50% in 2016 with the implication of having about 50% of Nigeria populace residing in the cities. Submissions of previous studies as Agbola (2005) and Adeniji (2007) on housing programmes appraisals in the country in the last thirty years revealed no significant positive achievement. Findings from recent studies on property use conversion in Nigerian cities have revealed that a significant proportion of land and buildings in urban areas have been converted from their original use to some other uses especially from residential use to commercial uses (Adegunle et al. 2016, Agukoronye & Nwankwo 2002). These studies further established strong direct relationship between the rising property use conversions and the rapid urban rental growth in our cities. The necessities for the understanding of change process in our cities, its agent and beneficiaries that can be used as planning and management indicators for a functioning city have been stressed by Fabiyi, (2006). Hence the word property or land use conversion is used interchangeably in this paper to mean the same thing.

This study therefore focuses on the analysis of the rental trends and influence of the conversions of residential properties to commercial use on rental value performances in Osogbo with the view that improved and effective land use conversions would help in the stability of property rental value performances in the study area. To achieve the aim, the objectives set for the study are to: identify the causes of property use conversions from residential to commercial uses in the study area; access the trend in the rental performances of before and after use conversions and to evaluate the influence of property use conversions on rental values in the study area. Thus, the study seek to provide answers to the following pertinent questions: What are the causes of property use conversions in the study area? What is the trend in property rental values in the study area? Does property use conversion exert statistically significant influence on rental value trends in the study area?

JUSTIFICATION FOR THE STUDY

The raising wave of Property use conversions is a major challenge confronting most cities in Nigeria. Nwachukwu and Ukpabi (2008) argued that property owners embarked on property use conversions especially from residential to commercial uses in the bid to maximize rental return. The alterations in land use pattern of cities, housing stock depletion and the consequential hike in urban rentals have been attributed to property use conversions activities (Ankeli et al. 2019, Adegunle et al. 2016, and Agukoronye & Nwankwo 2002). The trending use conversion phenomenon especially from residential to commercial uses according to Ankeli et al. (2019) is gradually becoming a common sight in the city of Osogbo as every available residential properties fronting major streets or roads in Osogbo have either been converted to shops, offices or business premises or are in the process of such conversion. More so, the influx of people and business ventures from the proximate bigger cities as Lagos and Ibadan is not helping matter as commercial land uses are gradually taking over residential land spaces thereby enhancing the steady succession and invasion phenomenon resulting in the redefinition of the city land use structure and the denial of the urban poor access to decent and affordable residential accommodation within the city. The gradual formations of urban slum settlement, conflicting urban land uses, evolving rental market in the metropolis and land ownership conflicts are occurrences that if not critically examined and controlled could bring about aesthetic problems aside other social vices. It is on this bases that study of this nature is considered justified, appropriate and timely.

THEORETICAL FRAMEWORK

Several theories have been propounded by earlier scholars on land use, development, management and control. Verburg, *et al.*, (2004) in their attempt to appraise the patterns of land

use conversions and its determinants in the Netherlands advocated for the understanding of the multifarious interactions that exist between man and his physical environment. Egbenta, (2009) validated the postulation of economic theory premised on the idea that economic activities expansion absorb other abutting land uses through space competition and ability to pay higher rent (bid rent theory). Qina *et al.* (2016) concluded that bearing in mind the specific land uses, Wingo's (1961) rent The theory of the totality of the relationship by Wingo assesses and incorporated the specific land uses attributes that exists between the components and its surrounding environment in land offer prices. This study is hinged on economic theories validated by Egbenta (2009). The identified conversion factors that was tested were gotten from previous literature on land use.

LITERATURE REVIEW

Conversion in the use for which a property or land is intended, zoned or approved for has become a common phenomenon in most Nigerian cities. Fabiyi (2006) viewed land or property use change as the reflections or the indirect consequences of economic growth through which the structure and functioning of the ecosystem have been in one way or the other altered. Abiodun et al. (2011) observed that the degree of land use conversions varies with the time under consideration as well as with the geographical locations. Ogungbemi (2012) examined factors influencing change in use and its attendant problems. The study posited that land use conversion is induced by varieties of factors among which are economic, demographic, institutional, infrastructural, environmental attributes, and sociological factors. Ankeli (2007) argued that investors expected returns on the available use options (which could be financial, social or otherwise) often serves as the determiner for land use conversions. These studies were not specific on any of the influencing factors. Olujimi (2010) however, asserted that the negative effect of the factors of land use conversions damage the interest of investors, thus subsequently discouraging investment potentials and initiatives in the subsector. Olarewaju (2016) examined the spatio - environmental dimension of residential land use change along Taiwo road, Ilorin and discovered a statistically significant variation in residential property values. Olarewaju (2016) failed to specify the value type, hence there exist gap that need to fill. Iroham et al. (2013) assessed the trend in rental values of commercial properties in commercial hub of Akure. The study revealed that converted office spaces with the highest rental values have better investment fund recoupment potentials. The study failed to report the cause(s) of conversion. It is in an attempt to fill the observed gaps, determine the influence of property use conversion factors on rental values in the study area that this study test the conversion factors reported by Ogungbemi (2012).

METHODOLOGY

The study adopted survey research approach. Both quantitative and qualitative data were obtained and utilized for the study. Structured questionnaires were administered on respondents which comprise of estate surveyors and valuers (ESV), staff of the State Ministry of Lands and Physical Planning and tenants. To determine the properties to be selected for the study, all the properties along the selected arterial roads were enumerated and screened in order to select those that best exhibit conversions characteristics which invariably form the sample frame for the study. Out of the 760 properties enumerated, 445 exhibit conversion characteristics. Kothari's (2004) formula was adopted in the determination of the sample size for the tenants, hence 196 properties were selected as the sample size for the study on which questionnaires were administered. The sample frame for the ministry staff and ESV was taken as the sample size for the study since they are few. Data collected for the study through questionnaires sought information on land/property use conversions, rental values and causative factors of use

conversions. The information were later processed through the use of both descriptive and inferential statistical tools so as to give the overall evaluation of the trend in rental values caused by property use conversions. Descriptive statistical tools used for the study includes frequencies, percentages and averages. Variables from existing literatures were further used to test the perception of the respondents through the generation of weighted indices based on 5 point likert scale.

To measure the level of influences of property use conversion on rental values, structural equation model which is a more advance form of regression analysis was used to graphically present the level of influences of the independent variables (land use conversions) on the dependent variables (rental values) and build the model fit, while microsoft excel was used to depict the visual representations (Trend Model) of the before and after use conversion rental performances. The results are presented in the next section of the paper. To identify and rank the variables based on the perceptions of the respondents, a Relative Importance Index (R.I.I) was used. In calculating the R.I.I., the formula suggested by Lim & Alum and used by Dabara et al., (2017) was adopted. The formula is:

$$\textbf{R.I.I.} = \frac{\sum W}{A*N} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5N\ldots} \quad \ldots\ldots\ldots\

RESULTS AND DISCUSSION

Tables 1 and 2 present the demographic profile and the number of questionnaires administered on the respondents. All the ESV are registered with their professional body and holds not less than HND/BSc certificate for which 80% are principal partners. Table 2 shows the number of questionnaires administered on the respondents. 25 questionnaires were administered on ESV, 15 questionnaires were administered on relevant staff of the MLPP who are on grade level 10 and above and 196 questionnaires administered on tenants. In all, a total of 236 questionnaires were administered with only 200 questionnaires representing 84.75% of the total administered questionnaires properly completed and retuned for analysis. This was considered adequate for convincing analysis, as the analysis was based on the total number of questionnaires retrieved.

Table 3: Factors influencing Property Use Conversion in Osogbo

Conversion Factors	1	2	3	4	5	R.I.I	Ranking
Economic Factors	12	20	0	25	45	0.75	1
Demographic Factors	10	30	0	20	42	0.72	2
Environmental Attributes	15	34	0	18	40	0.71	3
Infrastructural Factors	15	35	0	17	35	0.65	4
Sociological Factors	10	46	0	16	30	0.63	5
Institutional Factors	20	50	0	12	20	0.53	6

Table 3 presented the critical factors influencing property use conversion in the study area. Economic and demographic factors (R.I.I. 0.75 and 0.72) are the most critical factors influencing the conversions of residential properties to commercial uses. This might not be unconnected to the influx of businessmen into the city, cheap cost of living and among others. The study further revealed that the least critical factor influencing land use conversion is institutional factor (R.I.I 0.53). Hence, there is the need for a more effective and pragmatic institutional framework for addressing the drivers of land use conversions in the state. The findings of the study are congruent with the submission of Ankeli et al. (2019).

Tables 4 shows the annual rental performances of converted purpose built residential two bedrooms, three bedrooms and tenement buildings to commercial uses in Osogbo from 2010 to 2019. The table shows the calculated arithmetic mean score and average annual rental change or differences for before and after use conversions. From the table, significant positive performance was noticed between 2017 and 2019 for two and three bedroom properties, while there was a dip in the rental performance of converted tenement building between 2015 and 2016. The reason for the dip in rent could be attributed to the desire for larger space by space users.

The trend model as represented in Figures 1, 2 and 3 below run the variables against time and further revealed that, annual rental values of after use conversions for two, three and tenement properties increases by ₦ 11,248, ₦ 17,994 and ₦ 2,553. Within the same period, rent for before use conversions only increased by ₦ 8,939, ₦ 13,739 and ₦ 2486 which shows that investment in after use conversions are more attractive, hence a factor for conversion.

Table 4: Average Annual Rental Values of Converted Residential Properties to Commercial uses in Osogbo

Location	**OSOGBO (Average)**								
Property Types	**Rent for Converted Two Bedroom [N]**			**Rent for Converted Three Bedroom [N]**			**Rent for Converted Tenement Building [N]**		
Year	**After**	**Before**	***Diff**	**After**	**Before**	***Diff**	**After**	**Before**	***Diff**
2010	63,000	52000	11,000	58,000	45,000	13,000	16,720	12,080	4,640
2011	63,000	52000	11,000	84,000	66,000	18,000	17,440	12,600	4,840
2012	90,000	59000	31,000	94,000	74,000	20,000	22,480	16,200	6,280
2013	104,000	84000	20,000	102,000	78,000	24,000	22,480	16,200	6,280
2014	104,000	84000	20,000	115,000	91,000	24,000	22,480	16,200	6,280
2015	115,000	94000	21,000	123,000	103,000	20,000	25,100	21,680	3,420
2016	129,000	107000	22,000	143,000	117,000	28,000	28,700	24,800	3,900
2017	144,000	113000	31,000	168,000	129,000	39,000	36,520	30,800	5,720
2018	150,000	119000	31,000	218,000	165,000	53,000	36,520	31,200	5,320
2019	162,000	126000	36,000	228,000	175,000	53,000	38.520	31,600	6,920
Mean	**84,375**	**66,625**	**23,400**	**101,563**	**78,125**	**29,200**	**19,865**	**15,674**	**5,360**

*Differences in average rentals of converted properties

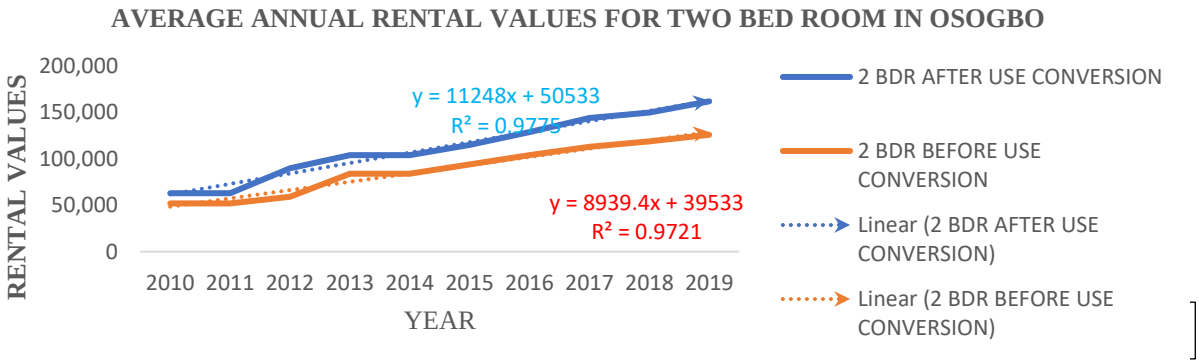

Fig 1: Average Annual Rental Trend of Two Bedroom Properties in Osogbo

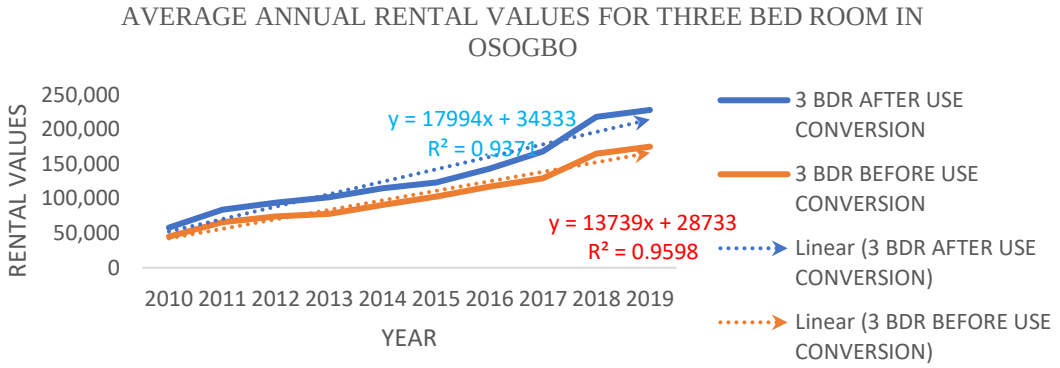

Fig 2: Average Annual Rental Trend of Three Bedroom Properties in Osogbo

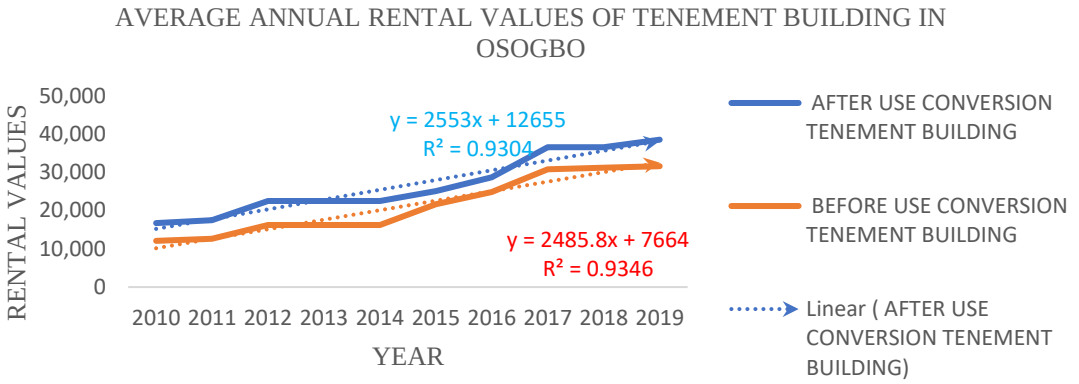

Fig 3: Average Annual Rental Trend of Tenement Building Properties in Osogbo

The regression weights in Table 5 shows the coefficient of demographic factor to Land Use Conversion which is 0.089. This indicated that the influence of a single unit increase in demographic variable contributes 0.089 unit increase in Land Use Conversion in the study area, hence it has a positive significant effect on Land Use Conversion. Increase in Economic factors by a single unit, brings about 0.361 unit increase in Land Use Conversion. Increase in Sociological factors by a single unit contributes 0.004 unit drop in Land Use Conversion.

Table 5: Regression Weights and Significance Value

Construct		**Construct**	Estimate	S .E	C.R	Label
LANCONV	<---	DEMOFAC	.089	.022	4.045	***
LANCONV	<---	ECOFAC	.361	.111	3.252	***
LANCONV	<---	SOCIOFAC	-.004	.020	-2.000	***
LANCONV	<---	ENVIATTRI	.032	.007	4.571	***
LANCONV	<---	INSTFAC	-.026	.005	-5.200	***
LANCONV	<---	INFRAFAC	.100	.045	2.222	***
Rental	<---	LANCONV	.028	.013	2.153	***
HOUSHORT	<---	Rental	1.000			
HIGOCCURATE	<---	Rental	.721	.267	2.696	***
ENVIPROB	<---	Rental	.012	.286	0.042	
URBANCRIME	<---	Rental	.044	.014	3.142	***
DEFPAY	<---	Rental	9.728	1.236	7.870	
LANDENCRO	<---	Rental	-.525	.133	-3.962	***

***Indicates significant level

The construct used for the study are interpreted as follows:
LANCONV = Land/ property Use Conversion, ENVIATTRI = Environmental Attribute
INSTFAC = Institution Factors, INFRAFAC = Infrastructural Factors, SE = Standard Error
CR = Critical Region, DEMOFAC = Demographic Factors, ECOFAC = Economic Factors, SOCIOFAC = Sociological Factors
Table 6 revealed the result of the determiners which are ratio of CMIN-DF, Goodness-of-Fit Index (GFI), Normed Fit Index (NFI), Comparative Fit Index (CFI), Tucker Lewis Index (TLI) and Root Mean Square Error of Approximation (RMSEA). The required level set by Hair, *et al*., (2006) and adopted for this paper are: GFI = (spec. > 0.90), NFI = (spec. > 0.90), CFI = (spec. > 0.90), and RMSEA = (spec. < 0.080).

The structural equation model in figure 4 below depicts the graphical presentation of the regression weights and their significance values in Table 5 above.

Table 6: Model Fit Summary

Fit Statistics	**Obtained**	
Index Name	**Index Values**	**Comments**
Root mean Square Error of Approximation (RMSEA)	0.038	Required level achieved
Goodness of Fit Index (GFI)	0.987	Required level achieved
Tucker Lewis Index (TLI)	0.954	Required level achieved
Normed Fit Index (NFI)	0.925	Required level achieved
Relative Fit Index (RFI)	0.995	Required level achieved
Degree of freedom	59	
Chi-square	303.290	
Chi-square Significance level	0.000	Required level achieved
CMIN/DF	2.438	
PCLOSE	0.040	Required level achieved

It shows the covariance between the variables through the double headed arrows, the estimate of error variance 'e' and the summaries of the proportion of variance in the dependent variable explainable by the collective sets of the predictors display as R^2 (on top of box) . It correlates and integrates all the factors for land use conversion constructs that provides the link from the land use conversion factors to its effect on rental values. The model indicated significant influence of land use conversions on rental with p value of 0.040 which suggested a good fitness (structural model) for the data collected and used with a corroborative value for the good model fit.

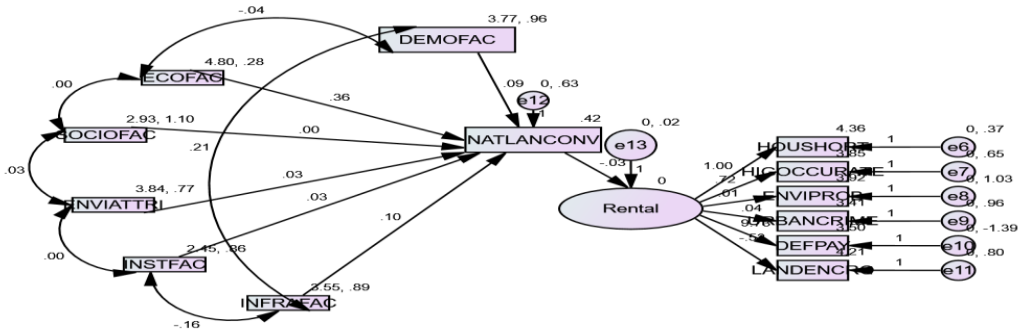

Fig. 4: Structural model of Land Use Conversion Factors and Rental Values in Osogbo

CONCLUSION

The study evaluates the causes of property/land use conversions and its influence on rental vales in Osogbo, Nigeria and confirmed the restructuring of the city land use due to the steady conversions of residential buildings fronting arterial roads to commercial uses. The study further discovered that, property use conversion influences rental value performances or trend and contributed to the depletion of residential housing stock with the consequential effect of high rental regime, land use infiltration, among others. Again after use conversions rental tend to perform better and have recoupment potentiality than before use conversions' rental values. In order to stabilize the rental market, the paper therefore recommend the creation of property use conversion unit in the state ministry of lands that will monitor property use activities in the

state, effective and efficient institutional framework for land use control mechanisms and incentives to residential property developers/investors.

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Evaluation of Passive Cooling Design Considerations in Faculty of Basic Medical Science Buildings in Northern Nigeria

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Abstract:
The most substantial discuss currently in the built environment of architectural practice and education is "Passive Design" because it has progressively become difficult for professionals to ignore its concern, considering the energy supply gap especially in Nigeria.Mechanical form of cooling,lighting and ventilating of educational buildings has continuously proven to be unsustainable. More so, it is important for faculty buildings to maintain a conducive thermal environment because of the negative impact, the lack of such could have on student's cognitive abilities and academic performance.This paper aims to identify the passive cooling design strategies incorporated inFaculty of Basic Medical Science Buildings in Northern Nigeria. The study adopted a descriptive survey method and data on passive cooling design strategies were collected through observation schedule.The random sampling method where the frequency of use and effectiveness of passive cooling design strategies were studied in six (6) sampled faculty buildings. Indicative findings from the studied samples were statistically analyzed and interpreted to show if the passive cooling design strategies were appropriately integrated to achieve thermal comfort. The result showed that passive cooling design considerations were not properly integrated in Faculty of Basic Medical Science Buildings in Northern Nigeria.It is recommended that passive cooling design strategies such as proper building orientation, adequate landscape elements, proper openings, adequate building envelope, thermal insulation, and adequate shading devices should be appropriately incorporated in the design of buildings, particularly faculty of Basic Medical Science Buildings to achieve thermal comfort.

Keywords: Faculty Building, Passive Cooling, Design Strategies, Natural Ventilation, Thermal Comfort

INTRODUCTION

The most substantial discuss currently in the built environment of architectural practice and education is "Passive Design" as it has progressively become difficult to ignore the concerns by professionals in the built environment (Stamas*etal.*, 2008).Empirical evidenceshighlight the continuous increase in temperature and greenhouse emission as a result of massive urbanisation, industrialization and advancement in technology(IPCC, 2014). However,green architecture or green design has been discussed by various scholars as an approach in advancement of sustainable architecture towards eliminating the emission of greenhouse gases (Bulus*etal.*, 2017).

According to the American Society of Heating, Refrigerating and Air Conditioning Engineers, the mechanical equipment has a higher maintenance and low replacement regime generally than natural ventilation approachASHRAE (2004). One of the ways of preventing high rate of dependence on active energy system for indoor comfort is for the designers to cater for the extreme temperature through adoption of Passive Cooling design considerations from the design stage (Akande, 2010).

The incorporation of Passive Coolingdesign strategies is aimed towards mitigating potential negative impact of greenhouse emissions on the well-being of the building occupants and the environment through the use of an "eco-friendly" construction materials and principles (Jackie, 2019). In addition, Passive measures, specifically natural rather than active means of cooling, can significantly reduce the energy intake and are adopted according to the local climate (Hatamipour and Abedi, 2008). In general, passive design balances all aspects of the energy use in a building (Rosenlund, 2009). The need to reduce the consumption of energy and give users more controlover their immediate environments, are good reasons for designers now to

re-evaluate the role of natural ventilation in buildings and to become familiar with thebasic principles involved (Hyde, 2017).

This study assesses and evaluates the design features for passive cooling in Faculty of Basic Medical Science Buildings to help architects and other built environment professionals achieve the desirable indoor environmental air quality. This would encourage new ideas in the design of Faculty buildings and also encourage the use of passive cooling design techniques in Faculty designs especially in the hot-dry climatic region.

Passive Cooling towards Thermal Comfort in Faculty of Basic Medical Science Buildings

Passive cooling design uses free renewable energy sources such as the sun and wind to provide ventilation, cooling, and lighting needs for buildings. This furthermore removes the need to use mechanical ventilation and cooling. Adopting passive cooling means decreasing differences between outdoor and indoor temperatures, improving indoor air quality and making the building both a better and more contented environment to live and work in. it can also decrease energy use and environmental effects such as greenhouse gas discharges. Interest in passive cooling design has developed recently - particularly in the last decade – as a part of crusade towards sustainable architecture. Well-designed envelopes maximise cooling movements of air and excludes the sun in the hot season.

There are many kinds of passive cooling strategies that can be suggested for use in hot – dry climate such as northern Nigeria. Design strategies that decrease the use of mechanical cooling systems include the selection of suitable glazing for windows or skylights, proper window placement and daylighting design, proper sized shading of glass when heat gains are being avoided, the use of light or reflective-coloured materials for the building envelope and roof, careful siting and wise orientation decisions alongside appropriate landscaping design. The above passive cooling elements are considered when improving the performance of a complex system designed to provide occupants with a comfortable, safe, and attractive living and work environment.

According to Abbaszadeh (2006), thermal comfort is regarded as a state of mind that is satisfactory with the thermal environment.Furthermore, it is assessed by subjective evaluation as a result of the nature of factors to be considered such as humidity, air velocity, metabolic rates, clothing levels, physiological state, radiant and air temperature. The occupant's satisfaction with their environment is importantas it affects health and productivity. Surveys have shown considerable correlation between optimal thermal comfort with improved cognitive abilities and productivity. However, thermal discomfort can result in sick building syndrome which has negative impact on the occupants (Mujtaba and Halil, 2017). Adoptingpassive cooling strategies is considered as a better alternative to mechanical cooling in providing satisfactory thermal comfort to building occupant. More also, this will help to lower the energy requirement of academic buildings which requires mechanical cooling systems and reduce greenhouse emissions(Hyde, 2017).

METHODOLOGY

Research Method and Data Collection

The research method adopted for this study is the descriptive survey method. Data collected for the research were obtained from primary sources and include: Case studies, use of observation schedule. Case studies were carried out on existing faculty of Basic Medical Science buildings within the study area. The variables assessed are; window placement, daylighting design, the selection of suitable glazing for windows or skylights, size of openings, building envelope and orientation, roof material, use landscaping features, were evaluated

using observation schedule. Also, photographs of the buildings were taken in order to show the variables observed on the field as shown in plates I – VI taken from the case studies.

Plate I: Use of landscape elements at Birnin-Kebbi

Plate II: Extensive use of Balcony,UDU FUBK Sokoto

Plate III: Use of windowsand low application of vegetationat FUBK Birnin-Kebbi

Plate IV: Use of shading devices UDU Sokoto

Plate V: Faculty building with vertical shading horizontal shading device

Plate VI: Faculty building with device

Sampling Technique and Sample size

The research employed the use of purposive sampling based on the size of the faculty of Basic Medical Science buildings in Northern part of the country. Fourfaculty buildings were selected and assessed.

Table 1: Sample size, acronym, location and number of buildings observed

S/N	Sampled faculties	Acronym	Location	No.of buildings observed
1	Faculty of Basic Medical Science UDU Sokoto	UDUS	UsmanDanfodio University, Sokoto	1
2	Faculty of Basic Medical Science KASU	KASU	Kaduna State University, Kaduna	1
3	Faculty of Basic Medical Science BUK	BUK	Bayero University Kano, Kano	1
4	Faculty of Basic Medical Science ABU	ABU	Ahmadu Bello University, Zaria	1

Variables for the study

The data collection instrument used in this study to assess thermal comfort design features in faculty building is structured observation schedule. As listed in Table 2.0, variables such as proper window placement and daylighting design, the selection of suitable glazing for windows or skylights, proper sized shading of glass when heat gains are being avoided, the use of light or reflective-coloured materials for the building envelope and roof, careful siting and wise orientation decisions alongside appropriate landscaping design

Table 2: Parameters used for assessing thermal comfort design features in faculty buildings

S/N	**Parameter**
1	Vegetation (landscape)
2	Shading Devices
3	Openings (windows, courtyard and atrium)
4	Thermal mass and Insulation.
5	Building Orientation

RESULT AND ANALYSIS

The Tables 1 and 2 shows the selected faculty of Medicine buildings in Northern part of Nigeria, their location, number of buildings observed and the parameters used to assess them respectively. An assessment was done to determine if the passive cooling strategies used in the faculty of Basic Medical Science buildings studied were properly integrated.

Table 3: Degree of use of passive cooling elements in the sampled buildings

S/N	The degree of presence of element	Score
1	Very high	5
2	High	4
3	Moderate	3
4	Low	2
5	Very low	1
6	Not available	0

DATA REPRESENTATION AND ANALYSIS

a) Landscape Elements

The various types of landscape element (vegetation) were assessed to evaluate their degree of effectiveness on the selected facilities. The analysis shows that trees, shrubs and grasses have higher application on faculty buildings as they are the dominantly used landscaped elements with 100% and hedges at 67%.

Table 4: Passive Cooling Design Elements (landscape)

SN	Institutions	Trees	Hedges	Shrubs	Grasses	Climbers
1	UDUS	✓	✓	✓	✓	*
2	KASU	✓	✓	✓	✓	*
3	BUK	✓	✓	✓	✓	*
4	ABU	✓	✓	✓	✓	*
Total		4	4	4	4	0
Percentage		100%	100%	100%	100%	0%

b) Solar Shading Element

The shading elements used at the selected facilities were closely observed and a chart was projected to show the analysed result. Majority of the selected faculty buildings uses deep verandas (balcony) and landscape element for shading which were scored on their effectiveness.

Table 5: Passive Cooling Design Elements (landscape)

SN	Institutions	Horizontal fins	Vertical fins	Egg crate	Balcony	Landscape
1	UDUS	✓	✓	*	✓	✓
2	KASU	*	*	*	✓	✓
3	BUK	✓	✓	*	✓	✓
4	ABU	*	✓	*	✓	✓
TOTAL		2	3	0	4	4
PERCENTAGE		50%	75%	0%	100%	100%

d) Thermal Mass

The thermal mass materials used at the selected facilities were also observed and a chart was projected to show how effective they wereadopted. The faculty of Basic Medical Sciences in KASU shows considerablethe use of stone work on the external walls mainly for aesthetic rather than for insulation. More alsoceramic tileswere used internally as floor finishes for cooling as shown in Figure 1.

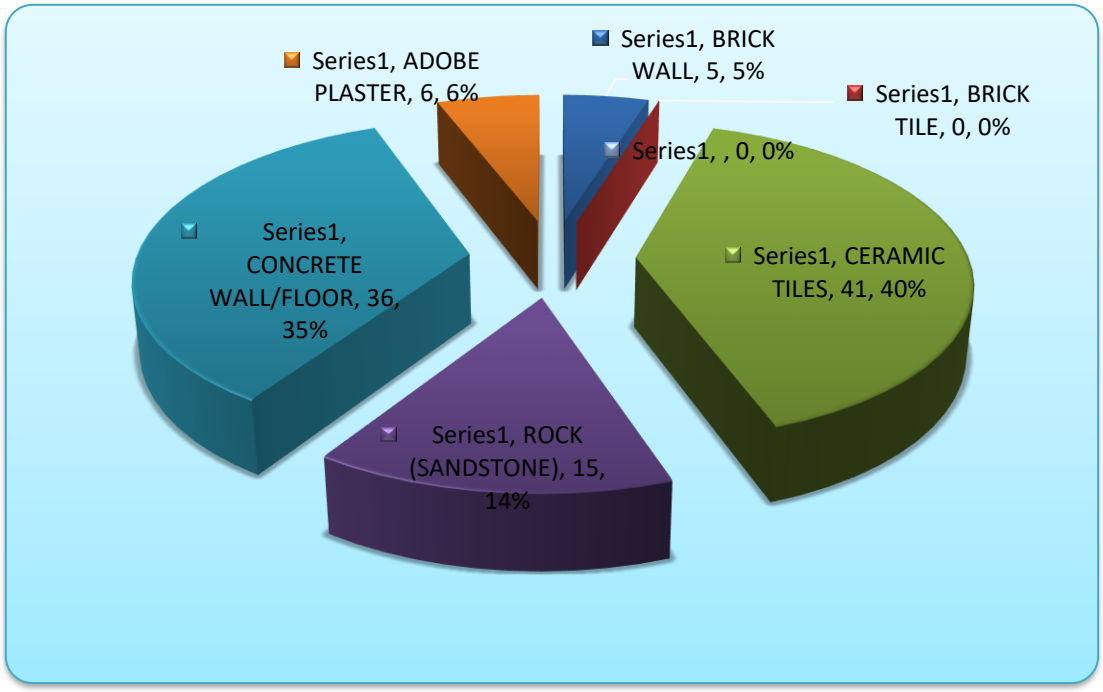

Figure 1:Material with high thermal massused in the facilities

e) Windows

The various types and form of windows were assessed. the height and positioning of windows was checked for window effectiveness on the selected facilities. The assessment showed as represented in Figure 2that 45% were fixed, while 55% of the studied buildings have projected windows. The observation also showed that 33% of Faculty of Medicine Buildings observed have clerestory windows particularly in UDUS.

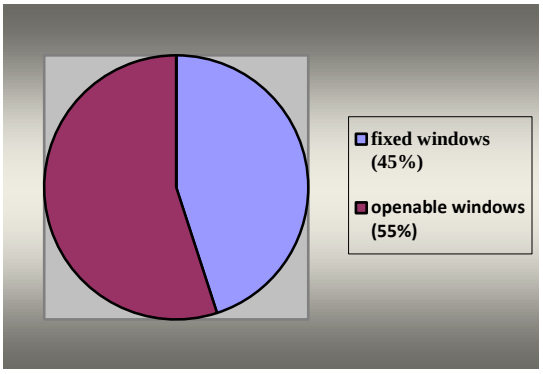

Figure 2: Various formsofwindows at the selected facilities

f). Courtyard

Courtyards used at the selected Basic Medical Science Buildings were observed to determine their level of effectiveness. After the observation, a chart was projected to show how effective they were utilized. The result of the assessment in Figure 3 showed that 66%of all courtyards observed were square orrectangular in shape, while 17% were either circular or oval in shape like that of the faculty of basic sciences in BUK.

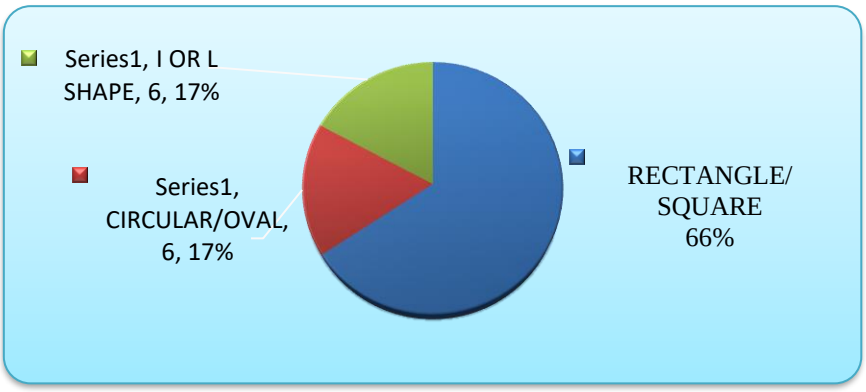

Figure 3: form of courtyard at the selected facilities

g). Building Orientation

From literatures reviewed, the building longitudinal axis should be along the East-West direction, so that the north and southern facades takes the lesser amount of solar radiation during the summer period. Hence, this paper assessed the different orientations adopted in siting the selected buildings. The result as shown in Figure 4indicates that 75% buildings have their longitudinal axis along are the North - South direction while the 25% East – West. This implies that orientation of a building was not giving proper consideration to reduce solar heat gain as it affects the room temperature and thermal comfortof occupants

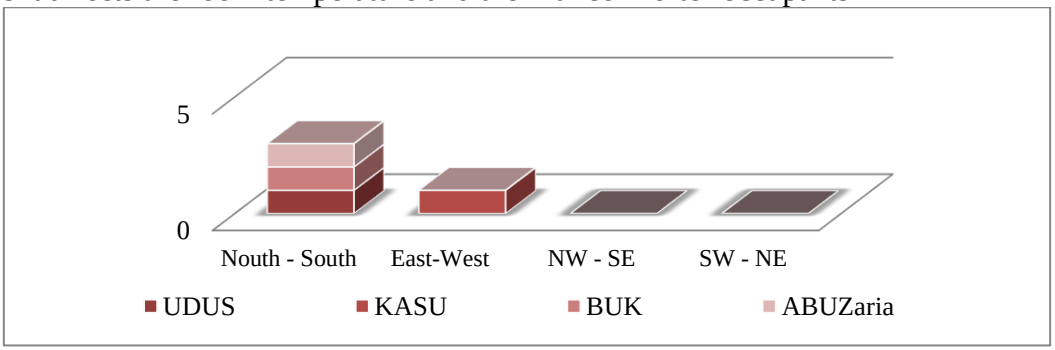

Figure 4: Building orientation

FINDINGS

From the results presented above, it can be deducted that passive cooling design strategies were not properly incorporated or designed for in faculty of basic medical science buildings in northern Nigeria. This non integration of these cooling elements has led to the use of artificial cooling methods which consume very large amount of energy and release harmful gases like greenhouse gases into the environment.

CONCLUSION

The concept of passive cooling design strategies proposes using design strategies to decrease reliance on mechanical cooling and ventilating. As analysed, the faculty of Basic Medical Science Buildings in Northern Nigeria were designed with little considerations for passive cooling design strategies as most of the buildings rely on artificial cooling and ventilating which have adverse effect on the environment. It is recommended that designers and developers in the built environment should resolve to adopt passive cooling design strategies to reduce over reliance on mechanical means of cooling, thereby ridding the environment of harmful gases.

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Policy Issues and Integration Settlement for Sustainable Development in FCT Abuja

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Abstract

The study assesses resettlement policies in the Federal Capital City, Abuja and its effects on the suburban growth, environment and development of the indigenous ancestral settlement at Karu-Abuja. This study aimed at evaluates policy issues and integration settlement for sustainable development. The study is undertaken with a view to establish extent of impact of integration policy as best option on the lives of Angwarn Gwari community. The study uses field survey were both quantitative and qualitative techniques were adopted and questionnaire were administered to purposively fifty-eight (58) household of original inhabitants. A total of 42 (72.41%) respondents consisting of men, women and youths were retrieved while penalty scoring was assigned to relevant variables obtained using Likert's scale. The research collected data using a uni-variated analysis on 11 rated items on five-point scale using inferential statistics techniques, the sum weighted score (SWS), mean weighted score (MWS)) rating was obtained. The research findings identified overwhelmingly "agreed" response of satisfaction with the statements as evident in the significant value that integration policy has positive impact on the indigenous people. The study reveals that the city is growing faster than the provisions of its master plan and that integration policy, if well implemented would have been best option against total eviction and evacuation as communities are being displaced. The study recommended that the community can be self- reliant to improve their lives educationally, socially, and economically. The interviewees indicate thanks to the government for accepting integration of their community.

Keyword: Abuja- Karu, Resettlement, Integrated Settlement, Resettlement Policy, Sustainable Development.

INTRODUCTION

The movement of the Federal capital territory (FCT) from Lagos to Abuja emerged as the major drivers of infrastructural development that stimulated massive population induced displacement and resettlement in Nigeria. A significant proclamation made by the Nigerian Government in 1976 revealed several resettlement policies been formulated in order to resettled it original aborigine inhabitant. This was done to liberate the capital territory from any primordial sentiment (IPA ,1979), and to empower the government to take effective control, plan and build up the new city with no encumbrance (Chima and Ahmadu, 2019). The creation of FCT brought about different resettlement policies and has been largest and most prominent development of construction site in recent times (El Rufai, 2012).. With the establishment of the Federal Capital Development Authority (FCDA) which is charge with the responsibility of planning and building the city underwent different policies change due to several challenges that undermined the initially adopted policies (Mabogunje, 2001, Abmere, 2001, Momoh el at. 2018). This began with the total evacuation policy of 1976 followed by partial resettlement policy (1978) then the integration policy of 1992 and finally completes resettlement policy (2005).The shift in policy implementation is a major root cause problems of squatters settlement and land administration in the FCT (Jibril, 2006). However, this policies could not achieve its purpose due to bottled neck and none adherence by the inhabitants, which Owei (2015) posit has made FCDA not to have a consistent policy direction. The integration policy is one of the laudable policy embrace by the inhabitants, which seeks to avoid resettling the indigenous populations in new areas, which other policies entailed with the need to pay large compensation. The element of integration is envisaged and planned to reduce the disruption in the way of life of the people, environmental hazard and linking the settlement to the new-up-coming infrastructural developments and services. However, the implementation of the integration policy reveals that there are a number of problems that has been faced by other pilot resettlement such as Garki, which shows that the policy has failed to achieve its main objectives despite the potential advantages over other policies. Therefore, this study seeks to address the need to focus on the integration policy by identifying with the inhabitant of Karu-Site by applauding the benefits of this appreciable policy on the impact on the community. The aim of the study is to examine the resettlement policies in Abuja, and with focus on the implementation of the Angwar-Gwari integration resettlement. The objectives are: to assess the impact of integration policy on the indigenous people of Angwar- Gwari

community and to access the contribution of policy change to the growth /need of the unplanned settlements within Abuja peripheral.

LITERATURE REVIEW

Resettlement whether in the form of voluntary or involuntary always has its repercussion on the Affected Persons (APs) (Jubril, 1990). The group of people being compelled to pave way for "development" will unavoidably encounter a decrease in their standard of living as they remain to lose their abode and socio-economic and cultural fabric, and tear the existing communities and creates risks of impoverishment, as it dismantles indigenous production system and way of existences (Cernea 1991, Tan & Yao 2006). Jubril (1990) posit that the informal networks and kinship ties that sustained these communities in times of need are displayed. The displaced community suffered the loss of economic opportunities and businesses lose, productive farmlands and other forms of livelihood were also being dismantled (Chima and Ahmadu, 2019). During relocation or adaptation process, APs may face physical and mental stress (Woube, 2005). These entire factors will definitely affect the livelihood of the people (Agba, Akpanudoedehe and Ushie, 2010). Musa el at. (2017) posit that the main benefit and elements of resettlement is support community development such as: Community Centre, Schools, Place of worship, Boreholes, houses, tarred roads, electricity, movement allowance and compensation etc. These elements are expected to turn the people around in terms of poverty alleviation, job creation which enhanced standard of living. Resettlement Scheme as based on the United Nation's philosophy states that "no resettled person should emerge from the resettlement scheme worse off than he was before displacement". Despite all this effort put in place to actualize the conformity of these Affected Persons (Aps), they are always a prolonged symptom of constant conflicts between the government and the indigenes of the FCT (Ahmadu, 2017). In most cases, government's attempt towards resettlement is faced with stiff resistance from the affected people. This means that the series of resettlement policies experimented with have not yielded any favorable result. Consequently, the major focus of this paper among every other finding is to explore and appraised integration resettlement strategy employed in FCT, it influenced on the indigenous inhabitant of Angwar- Gwari resettlement community of Karu suburban fringing periphery settlement.

FCT RESETTLEMENT POLICY AND THE ISSUE OF INTEGRATION

The policy of integrating some of the indigenous settlements into the fabric of new developments was conceived as an aftermath of the failure of the other policies due to high costs of compensation. The integration policies adopted for the resettlement of the populations Affected Peoples (APs) by the new federal capital city (FCC) development project in Abuja, is as a result of government unprepared for such a dramatic transformation, so the policy failed in its implementation (Balogun, 2004, Levan and Olubowale, 2014). Woube (2005) posit that most of the resettlement projects were designed with short-sighted political gains in mind, having operated as isolated entities, rather than as "integrated" development programmes. Integration resettlement policy of 1992 was opted for by Maj. Gen. Gado Nasko (Rtd) and widely adopted for Garki Village (within Garki II District of FCC Phase I), except for the people to be affected by the construction of access roads and other infrastructure that were to be relocated within proximity of the village be revoked. The policy was probably based on two main premises: (a) that it could be unwise to move out the indigenes who are Nigerians to make way for other Nigerians (b) that existing policy is costly while Integration is cheaper and reduces cost effective. However, this policy suffered setback due to poor implementation and violates the master plan stipulation that assumed no villages exist in the FCC areas (IPA, 1979). After twenty-seven (27) years since its adoption in a pioneer scheme at Garki, the policy had been sustaining other fringing peripheral settlement in the satellite town of Karu, Abuja. Balogun (2004) opined that the implementation of integration policy has revealed and avoided some of the problems of other policies which Olawepo (2008) opted has provided alternative opportunities for the feed need of the Affected People. UNHCR (2005) estimated that the number of people displaced due to development from 1980 to 2000 is within the range of 200 million. That is why it necessary to uphold the impact of integration policy. Filaba (2002) opined that as from 1990s there were evidence of social transformation and improved living condition in the satellite town.

MATERIALS AND METHODS

Karu is one of the fringing satellite town located at the peripheral settlement of the coast boarder of Nasarawa state. A four-minute drive from city center and well distinguished among suburban settlement that house many government parastatasl and agencies; such as Custom Quarter, Foreign Affair, Department of State Security Services (DSS), Nigeria Intelligent Agency (NIA), Central Bank Executive quarter., various location of Defence Intelligent Agency (DIA) quarters and Training school, Economic and Financial Crime Commission (EFCC) Training School among others. Karu Settlement is ranked as the most planned satellite town in the FCT. The Angwar – Gwari settlement are handful dwellers of less than 300 indigenous people, surrendered by dense population of the larger work force of other Nigerians. A none gated community which has enjoyed the ambiences of social infrastructural development by integration. They were compulsorily moved out of their original settlement and resettled directly opposite the EFCC training school by the Obasanjo government in 1999.

The sampling techniques adopted were purposive and reconnaissance survey carried out with the guidance of a local field assistant who identifies the houses belonging to the original inhabitants to be fifty-eight (58) household, and were administered questionnaires. A total of 42 (72.41%) respondents consisting of men, women and youths were retrieved and used for the study. The questionnaire was divided into 2 parts; part (A) elicited the demographic data of respondents while part (B) sought out their participation, well-being and impact of integration policy on their community. Using the Likert scale varying from one to five with response style of strongly positive to the issue or strongly Agree (SA=5), some extent positive to the issue or Agree (A=4), neither negative nor disagree to the issue or Undecided (U=3) some extent unfavorable to the issue or Disagree (D=2), strongly unfavorable to the issue or Strongly Disagree (SD=1), was designed and employed while the weighted score of 1 to 5 was used to multiply the respondents' rating value options of variables.

$$\text{Relative importance index} = \frac{\sum w}{AN} \qquad \text{(i)}$$

Table 1: Guide to degree of impact based on the Likert scale calculation

Degree of Impact	Rating Weighted Value	Rating	Interpretation
High Positive Impact	4.0-5.0	1	Most significant
Positive Impact	3.0 - 3.99	2	significant
Negative Impact	2.0 - 2.99	3	Less significant
High Negative Impact	1.0 - 1.9	4	

Source: Fieldwork survey, 2019.

FINDINGS AND DISCUSSION

From the research finding it is evidence that the resettle community using the grand means of 3.0 – 5.0 and 1.0 – 2.99 as both positive and negative impact respectively, to measure the leveled issues of integration policy on sustainable development of the community aspiration and needs in FCT Abuja. It is overwhelmingly agreed with the statements as evident in the significant value that integration policy has positive impact on the indigenous people.

Demography Characteristics of Respondents

The demographic characteristics of the sampled respondents have been captured in table 1. Males, 29(69.05%) while females 13(30.95%). A greater proportion of the respondents were within the ages of 30 and 50 years. Marital Status shows that 28 (66.67%) respondents are married during pre-integration, while post-integration is 25(59.52%),. Also, 11 (26.19%) are single and 10(23.81%) during pre and post integration respectively, while other respondent 3(7.14%) and 5(11.91%) represent widow/ widower at both pre and post integration respectively. Work Place Location shows that during pre-integration 7 (16.67%), 17(40.47%), 18(42.86%) work at Abuja City center, Nyanya/ Maraba and Karu respectively, while post-integration has more respondents 20(47.62%) work in Abuja city center and Nyanya/ Maraba (9(21.43%) and Karu (13(30.95%) respectively. Family size It quite a tradition within Gbagyi communities to live in a circulated homestead, where 11(26.19%) respondents lived 10 and above household, 22(52.38%) lived in 5-9 household with only 9(21.45%) respondents lived in 4 or

less during pre-integration, while at post-integration 22(52.38%), 13(30.95%) and 7(16.67%) respondents lived in 10 and above, 5-9 and less than 4 households

Table 2: Other Effects of Integration

Respondents' Variables	Criterial	Pre-Integration No Involved (42)		Post Integration No Involved (42)	
Gender	Male	29	69.05	29	69.05
	Female	13	30.95	13	30.95
	Total	42	100.0	42	100.0
Age	15-30	19	45.24	-	-
	30-50	15	35.71	-	-
	50 and above	8	19.05	-	-
	Total	42	100.0	-	-
Marital Status	Married	28	66.67	25	59.52
	Single	11	26.19	10	23.81
	Widow/widower	3	7.14	5	11.91
	Divorce	-	-	2	4.76
	Total	42	100.0		100.0
Work Place Location	Abuja city	7	16.67	20	47.62
	Nyanya /Maraba	17	40.47	9	21.43
	karu	18	42.86	13	30.95
	Total	42	100.0	42	100.0
Distance to the city	<less than 2km	38	90.48	38	90.48
	2km -5km	4	9.52	4	9.52
	Total	42	100.0	42	100.0
Family size	<4 or less	9	21.43	22	52.38
	5- 9	22	52.38	13	30.95
	10 and above	11	26.19	7	16.67
	Total	42	100.0	42	100.0
Mode of Transportation to Work	Privately owned vehicle	2	4.76	11	26.19
	Mass transit bus	23	54.76	13	30.95
	Taxi	4	9.53	18	42.86
	Trekking	13	30.95	-	-
	Total	42	100.0	42	100.0
Occupational Structure	Farming	25	59.53	13	30.95
	Trading	7	16.67	3	7.14
	Civil servant	2	4.76	10	23.81
	Wage Employment	3	7.14	16	38.10
	Unemployed	5	11.90	-	-
	total	42	100.00		100.0
Changes In Income	< N5,000	27	64.28	-	0.00
	N5.000-10,000	11	26.19	13	30.95
	>N10,000	4	9.53	29	69.05
Educational level	uneducated	24	57.14	5	11.91
	Primary	10	23.81	14	33.33
	secondary	5	11.91	12	28.57
	Tertiary	3	7.14	11	26.19
	Sample total	42	100.0	42	100.0
Business transacting	Laundry man/ Restaurant	2	4.76	11	26.19
	Provision store/ Butcher/Hawker/	5	11.91	15	35.71
	Fruits/vegetables seller	3	7.14	9	21.43
	None	32	76.19	7	16.67
Semi-skill trade	Sample Total	42	100.0	42	100.0
	Mechanic/Vulcanize/ Welder	1	2.39	17	40.48
	Electrician/ Tailor	2	4.76	7	16.67
	Carpenter/ painter/ bricklayer	4	9.52	12	28.57
	None	35	83.33	6	14.28
	Total	42	100.0	42	100.0
	Owned	32	76.19	38	90.48
	Government quarters	-	-	-	-
	Sample total	42	100.0	42	100.0
Security	Vigilante,	32	76.19	8	19.05
	police	2	4.76	33	78.57
	None	8	19.05	1	2.38
	Sample Total	42	100.0	42	100.0
HOUSE TYPE (Numbers Of Rooms In Compound)	1-5 Rooms	9	21.43	23	54.77
	6-15 Rooms	21	50.00	15	35.71
	16-20 Rooms	12	28.57	4	9.52

	Sample Total	42	100.0	42	100.0
Proximity to social basic amenities,	Schools-primary/ secondary	11	26.19	23	54.76
	Market/ Business center	7	16.67	13	30.95
	Region- church/ mosque	12	28.57	18	42.86
	Sample total	42	100.0	42	100.0
Accessed to public infrastructure	Electricity/ telecommunication	6	14.28	12	28.58
	Portable pipe borne water	6	14.28	14	33.33
	Sanitation/ Garbage disposal	7	16.67	10	23.81
	Road network/ water drainage	5	11.91	6	14.28
	None	18	42.86	-	-
	Sample total	42	100.0	42	100.0
communal relationships/ social interaction with neighbors	Home meeting	20	47.62	9	21.43
	Marriages/wedding celebration	13	30.95	12	28.57
	Birthday/ Party/ Religious Activity	9	21.43	21	50.00
	None	-	100.0	-	-
	Sample total	42		42	100.0
access to medical care services	Govt. Hospital	3	7.14	27	64.29
	Clinic/ private	-	16.67	10	23.81
	Traditional Herbal	39	92.86	5	11.90
	Sample total	42	100.0	42	100.0

SOURCE; Author field Research 2019

Distance to the city The respondents attribute the same distance to the main city bowl whereby both pre and post- integration are by38(90.48%) agree that the distance is less than 2km while 4(9.52%) accept 2-5km. Security has not been too challenging during pre-integration Vigilante were used to secure the communities against external forced / attack, 32(76.19%) respondents opt for local vigilante, 2(4.76%) police and 8(19.05%) for none, but at post-integration 33(78.57%) respondents opt for police security while 8 (19.09%) respondents stand with vigilante in support for security. Accessed to public infrastructure include electricity/ telecommunication line, water supply, sanitation, garbage disposal, road network and water drainage, which are 6(14.28%), 6(14.28%), 7(16.67%) and road network 6(14.28%) respectively. This although do not make much changes with post-integration with variable like road network and water drainage 6(14.28%), but improvement with 12(28.58%), 14(33.33%)and 10(23.81%) electricity/ telecommunication line, water supply, sanitation, garbage disposal respectively. Access to medical care services 39 (92.86%) respondents go to the traditional herbalist (native doctor) when they are sick during pre-integration, while only 3(7.14%) were able to access government hospital; meanwhile at post-integration total of 27(64.29%)go to government hospital and another 10(23.81%)were able to go to private clinic, with only 5(11.90%) respondent still go to traditional herbalist. Ownership of accommodation reveals that pre-integration 10(23.81%) rent accommodation, 32(76.19%) owned their houses. Post integration 38(90.48%) owned their houses while the remaining 4(9.52%)only rent their houses. Mode of Transportation to Work shows that pre-integration, only 2(4.76%) owned privately vehicles while 23(54.76%) go to work with mass transit bus while 4 (9.53%) use taxi to their various working places the other 13 (30.96%) trek on foot to their various working places. while post-integration 11(26.19%) owned respondents privately vehicles,13(30.95%) uses mass transit bus, with the rest 18(42.86%) uses taxi., as none of them are trekking. House type Traditionally, the Gbagyi being an agrarian community likes to live within the extended family system and this is demonstrated in pre-integration when the respondents of 21(50.00%) lives in compound of 6-15 rooms persons, while another 12 persons agree to live in 16-20 rooms in a compound, but this experiences becomes differed whereby during post-integration 23(54.77%) of the respondents live only in 1-5 rooms while only 4(9.52%) respondents live 16-20 rooms in compound. Business transacting Table 4.5 indicates that during pre-integration the Business transacting were 2((4.76%) were laundry/ restaurant, 5 (11.91%) of them were business men who are involved in various forms of business such as provision petty trading,3(7.14%) sale fruit with extra 32(72.19) having nothing to indulge in as a mean of making meaning living. But post integration would see various same business booming as such 11(26.19%), 15(35.71%), 9(21.43%) Laundry man/ Restaurant, Provision store/ Butcher/Hawker/ Fruits/vegetables seller and only 7(16.67%) not doing any business. Semi-skill trade Semi-skill trade shows the

respondents were able to boast their living whereby before integration only 1(2.39%) were mechanics/ vulcanize/ wielder, 2(4.76%)electricians/ tailored, 4(9.52%)carpenter/ painter and bricklayers with 35 of the respondents having nothing to do, However, after integration table 5 further shows that the population of those engaged in active Semi-skill trade worker of these settlement was remarkably increase as follow: 17(40.48%), 7(16.67%) ,12(28.57%) and 6(14.28%) respectively. Educational attainment of the respondents both before and after integration shows that Pre-integration 24(57.14%) were uneducated, 10 (23.81%) only attained primary, 5(11.91%) when to secondary school while only 3(7.14%) attained tertiary educational level, but subsequently with Post integration only 5(11.91%) do not have formal education, other 37(88.09%) who has pass through primary level. "Among the respondent 11 (26.19%) have passed through secondary school to tertiary institution". Occupational structure was improved upon due to proximity of Karu to the city center of Abuja and the resulting influx of people to the peripheral settlement, which has offered new opportunities. while at the time constraining the traditional occupation of farming as the main employment with low wages. At pre-integration 25(59.53%) were farmers, 7(16.67%) are trading out farm related produces.

The survey conducted has revealed that many people are now engaged in occupational structure other than farming related activities. Such as increase civil servant job 10(23.81%), wages employment jobs at various enterprise 16(38.10%)and the 5(11.90%) unemployment now gainful employed. Changes in income in table 4 above shows that majority of the respondent's incomes have increased. pre-integration indicates that 27(64.28%) earned less than N5000.00, with only 4 respondents earned above N10,000.00, whereby post –integration indicates that 29(69.05%) now earned above N10,000.00 and 13(30.95%) earned between N5,000.00-N10,000.00.

Table 3. Resettlement Policy Strategies and Effects on the Communities

Item Summaries	SA	A	U	D	SD			Std.	Decision
	5	4	3	2	1	SWV	MWV	Dev.	
policy options must capture the needs of the people	85(40.0%)	56(40.0%)	21(16.7%)	10(11.9%)	2 (4.7%)	174	4.142	0.099	Agree
The Host communities resisting Integrated policy	75 35.7%	40 23.8%	24 19.1%	14 16.7%	2 4.8%	155	3.690	0.087	Agree
Integration offers response to the communities need	80 38.0%	44 26.2%	15 11.9%	14 16.7%	3 7.1%	156	3.952	0.088	Agree
Lack of funds is a critical issue affecting implementation of resettlement policy in FCT	40 19.1%	24 14.3%	24 19.1%	24 28.6%	8 19.1%	120	2.857	0.068	Disagree
There is lack of political will on the part of the leaders	80 38.1%	52 30.9%	27 21.4%	8 9.5%	0 0.0%	167	3.976	0.095	Agree
The existing policy strategies need improvement for it to reflect the community aspiration.	65 30.9%	48 28.6%	27 21.4%	16 19.1%	0 0.0%	156	3.714	0.088	Agree
Government uses threats and intimidation to force people out of their place of abode	100 (47.6%)	64 (38.1%)	9 (7.1%)	6 (7.1%)	0 (0.0%)	179	4.261	0.101	Agree
Infrastructural facilities in the new sites are adequate	30 14.3%	24 14.3%	30 23.8%	30 35.7%	5 11.9%	119	2.833	0.22	Disagree
Resettlement policy option must in cooperate the people felt-need	60 28.6%	60 35.7%	21 16.7%	10 11.9%	3 7.1%	154	3.666	0.087	Agree
Integration policy strategies better than evacuation / partial	85 40.5%	60 35.7%	12 9.5%	4 4.8%	4 9.5%	165	3.928	0.093	Agree
The conditions of people who are relocate to other state better than you being here presently	15 7.1%	36 21.5%	36 28.6%	22 26.2%	7 16.7%	116	2.761	0.065	Disagree

Source; Author field Research 2019

Communal Relationships/ Social Interaction with Neighbors inquired about the level of people in satisfaction of the new location in comparison to the previous location, 20(47.62%),13(30.95%) and 9(21.43%) agree that their traditional home meeting marriage/ wedding celebration and the way of birthday and Religions were affected, meanwhile 9(21.43%), 12(28.57%) and 21(50.00%) respondents after post integration agree that traditional home meeting marriage/ wedding celebration and the way of birthday and Religions were improved upon since they were able to interact with the larger society. Proximity to Social Basic Amenities have been difficulty since only 11(26.19%), 7(16.67%) and 12(28.57%) respondents have accessed to primary/ secondary schools, market/business center and religion home in pre-integration, while 23(54.76%),13(30.95%) and 18(42.86%) respondents during post-integration respectively.

Table 3 presents the opinions of the respondents on the resettlement policy strategies and how they affected communities. The result shows that The FCT resettlement policy options must capture

the needs of the people and affected communities. This was expressed using 31 respondents representing about 80.0% agreed, while 7 respondents representing about 16.6% disagreed. This was further substantiated score of (MWV=4.142, SD=0.099). The Host communities resisting Integrated policy, was agree whereby twenty-five (25) respondents, representing 59.5%, while nine (9) respondents representing about 21.5% disagreed. The score of (MWV=3.690, SD=0.087) shows that the views of those that agreed. Integration offers response to the communities need. Twenty-seven (27) respondents representing 64.2% agreed, while ten (10) respondents representing about 23.8% disagreed. The score of (MWV=3.952, SD=0.088) indicates agreement with the statement. The Lack of funds is a critical issue affecting implementation of resettlement policy in FCT, but the affected community disagree with twenty (20) respondents opting for this which represent 47.7%, while another 33.4% agree, a total of 19.1% other respondents however, remained neutral on the issue. The less small score of (MWV=2.857, SD=0.068) show funding a resettlement policy is not the problem, but it implementation. As regarding the lack of political will on the part of the leaders to implement Resettlement Policy Strategies and Effects on the Communities, a total of twenty-nine respondents, which make up about 69.0% of the respondents agree that the government lack the political will. This could be seen in them in-consistence's decision on the litany of policies, while only eight (8) respondent (9.5%) disagree with this opinion, another nine (9) respondents remained neutral on the matter. The score of (MWV=3.976, SD= 0.095) over-whelm this. As regards whether any of the above-highlighted existing policy strategies need improvement for it to reflect the community aspiration. As regards whether any of the above-highlighted, seventy (25) respondents which is about 59.5% of the population agree, while eight (8) |respondents (19.05%) disagree, another nine persons (21.43%) remained neutral. The score of (MWV=3.714, SD=0.088) shows a confirmation of the position of those that agreed with the statement As for the statement regarding whether Government uses threats and intimidation to force people host communities out of their place of abode resettles, thirty-six (36) which is about (85.7%) of the total respondents agree, opting that despite every promises made the community were in lock fist with government agency on resettle, they posit that government policy has been failed, with much regard to Garki integration policy whereby the same government opt to relocate the same inhabitant to Apo. This show the wide gap in score of (MWV=4.261, SD=0.1010) of the respondents that agreed, while few three (3) respondents represented by (7.1%) disagreed. Also, the following alternative statement for the sake of emphasis also indicates that the strategies were all compatible with the felt-needs of the communities, by the provision of Infrastructural facilities in the new sites are adequate, twenty-five (25) respondents (47.6%) disagree while another twelve (12) respondents ((28.6%) agree, remaining another six (6) (23.8%) respondent's neutral on the issue. The score of (MWV=2.833, SD=0.22). It is disagreed that resettlement strategies may not be fully providing the communities with the needed Infrastructural facilities. From the analysis, it has been discovered that resettles and host communities to some extent have been satisfied with all the policy strategies irrespective of the benefits attached. The opinion of the community members on the influence of resettlement policy strategies (option) must in cooperate on the people‟ felt-need, this is evident with the statistical outcome of twenty-seven (27) respondents representing about (64.3%) who agreed with the statement, while eight respondents representing about (19%) disagreed. The score of (MWV=3.666, SD=0.087) supports the opinions of the people that agreed with the statement. This mark the fact integration policy has impacted greatly on the affected communities. The resettle community posit that despite strict rejection and resisting on option of integration policy from the on-set and irrespective of the benefits the policies offered today, integration policy strategies is better than evacuation / partial. This has been substantiated with the views of twenty-seven (27) (76.2%) respondents that agreed and a score of (MWV=3.928, SD=0.093) while other respondents represented by six (6) (14.2%) disagreed. That integration policy despite against all odours has provided succours to the original inhabitant generally. Lastly, the resettle community were asked about the socio- economic conditions of people who are relocate to other state better than you being here presently, nineteen (19) respondents (42.9%) disagree, while twelve (12|) (28.5%) agree with another twelve (12) (28.6%) respondents remaining undecided on whether the conditions of people who are relocate to other state are better. The score of (MWV=2.761, SD=0.065) attested to this.

CONCLUSION AND RECOMMENDATIONS

The integration and assessment of policies issues emerging from resettlement of the Angwar-Gwari Karu peripheral suburban fringing settlement shown that for twenty- eight (28) years after its implementation and thirteen (13) year later after it abolishment, integration policy do not woefully fail as perceived in many part of the FCT. The integration Policy of the Angwar-Gwari Communities analysis showed a significant difference in the opinion of the community members and the perceived general public on integration and other resettlement policies as being carried at different time/ stages in the FCT. Integration resettlement policy and effects on the communities shows the level of "*Agreed"* as to the extent to which policy strategies provides the needs for Sustainable development of the people. The finding posits that most members of the communities appeared to be more comfortable with option of integration resettlement, which serves as alternatives to many other communities. The location of Karu settlement at the fringing peripheries of the city bowl of Abuja allows integration policy achievable, Finally, it can be concluded that integration still remains a potentially superior option to other policies with the following recommendations: since members of the communities overwhelmingly opted for integrated resettlement, it means the government should implement that which reflects the people need. This is because the indigenes of the Federal Capital Territory by their nature are hospitable and welcoming to visitor and strangers who today are already part of their larger society.

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Assessment of Design Method on Fire Prevention Strategies for High Rise Buildings in Lagos, Nigeria

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Abstract:
High rise buildings are popular structures with improved construction activities and technology that help in reducing land scarcity, urban density and accommodate large families in lesser space. Fire outbreak is one of the risks associated with high rise buildings because the buildings consist of multiple floors which create a cumulative effect that require many people to travel through vertical distances. Fire outbreak in high rise buildings is always terrible as population of occupants in building make escape difficult or tedious. This study, therefore, assessed the design methods used to prevent the spread of fire in High Rise buildings in Lagos State. Qualitative research method was used with purposeful sampling technique employed; the researcher analysed 11 high rise buildings in Victoria island Lagos the findings show a high percentage of high-rise buildings in Lagos state adopt fire prevention strategies, however there is a clear lack of fire escape in most of the buildings. In conclusion, the paper suggests design ways of preventing the spread of fire in high rise buildings to avoid of loss of life and properties.

Keywords*: high rise building, life and properties, fire prevention strategies, fire outbreak, Nigeria.*

BACKGROUND OF THE STUDY

High population density and scarcity of land in urban centres contribute to the increase of high-rise and supper high-rise buildings in most cities. In most modern cities presently, high-rise structure is built to curtail over population, land scarcity and to also serve as symbol of status and tourist attraction as a result of it aesthetics (Ede, 2014). Chandwani (2012), added that, high rise building is a building greater than 75ft (23m), and generally with 7 to 10 stories. Despite the advantages of high-rise buildings stated above, there are numerous challenges facing high-rise buildings in Nigeria. Zahari *et al*. (2014), added that, fire outbreak is one of the many risks high rise buildings. As the buildings consist of multiple floors which create cumulative effect that require the occupants to travel through vertical distances on the stairs. To corroborate the assertion above, Abdullah (2011), states that, stack effect (temperature difference between two areas) is one of the negative effect of high-rise buildings as it creates series of pressure between the floors which would result to the movement of natural air capable of moving huge volume of heat and smoke when there is fire outbreak within the building. Onoyan-usina *et al*. (2017), added that, in Nigeria, factors such as power outages, power surge, illegal connections of electricity, improper electrical fittings, substandard materials, indoor use of generators, arson, and negligence of household are some of the causes of fire outbreak in Nigeria, Lantz and Skroder (2013), submitted that, most fire outbreaks in high rise buildings are associated with construction features capable of causing extensive fire and smoke spread which make it difficult for occupants to exit. In the same vein, Olagunju *et al.* (2013), opined that, fire outbreak in high rise buildings is always terrible as population of occupants in building make escape difficult or tedious. However, some of the features of high-rise buildings such as great height, structural complex, diverse function, and many others contribute greatly to many fire outbreaks in high rise condominium (Hassanain, 2009).

This research is aimed at identifying design methods on fire prevention strategies in high rise buildings in Nigeria. This method helps in protecting components of structural system and also delay the spread of fire through the use of fire-resistant materials, use of simple building forms, simple roof forms such as hip roof, and fire compartmentation.

General overview of high rise buildings

Al-Kodmany (2018), sees high rise building as a structure higher than 22m (72ft) with room to accommodate people permanently. Carrigan (2015), contributes that, high rise building can be defined as a building with 75 feet (23m) and above the lowest level of fire department vehicle access. Osunsanmi (2017), posits that, high rise building and other building components such as Elisha Graves Otis safety elevator which helped in vertical movement, steel frames invention of 1870, and invention of air conditioning in 1902 are proof of advancement in technology. Ismail *et al*. (2015) assert that, high rise buildings developed through three generations. The first was from 1870 to 1920. During those years, the exterior walls of the building were made of stones or bricks, cast iron and floors were made of woods, the elevator shafts were closed and the only escape route was through a single stairway. The second generation was from 1920 to 1940 which came to improve the first generation. The development in this second generation includes replacement of combustible construction materials. The third generation of high rise buildings began after the World War II (from 1940 to 2019). During this period, constructions were done using lightweight steel, reinforced concrete frame and exterior curtain walls (Ismail *et al*., 2015). Kavilkar *et al.* (2014), states that, high rise building is now popular worldwide due to the improved in construction activities, technology and its ability to reduce land scarcity, urban density and accommodate more population in small space. Xiuyu *et al*. (2012), added that, development in our urban economy, high population density and land cost have made high rise buildings and super high rise buildings to increase.

High rise development in Nigeria

The growth in population and increased urbanization has led to a great increase in demand for housing. In the advent of technology and limited supply of land for development, the idea of high rise development evolved to cater for more people. (Olanrele *et al*., 2014) Despite these advantages, there are challenges facing the development of high-rise buildings in Nigeria

High rise in this country are spared for the rich or people with high social status as the facilities of such buildings must be manage and deliver efficiently (Weldemariam, 2017). Presently there is increase of high rise residential buildings especially in Lagos where One Thousand and Four Tour (1004) Estate and Eric Moore Tower are located. The two towers were developed by Lagos State Development and property corporation (LSDPC). Other high rise buildings built in Lagos after that includes: Dangote apartment, Folwiyo Tower, Rose of Sharon Tower, Eko Pearl Tower, Niger Tower and many others are still under construction. Urban centres of most developed and developing countries are faced with a common problem of homelessness which is made worse through rural-urban migration (Ingwani *et al*., 2010). Presently there is increase of high rise residential buildings especially in Lagos where One Thousand and Four Tour (1004) Estate and Eric Moore Tower are located. The two towers were developed by Lagos State Development and property corporation (LSDPC). Other high rise buildings built in Lagos after that includes: Dangote apartment, Folwiyo Tower, Rose of Sharon Tower, Eko Pearl Tower, Niger Tower and many others are still under construction.

Nature of Fire

Raichur (2012), define burning or fire as a reaction of chemical substances and oxygen mixed with heat and accompanied by visual flame or incandescence. Reflex (2011), similarly opines that, Fire is a chemical reaction in which energy in the form of heat is made. The chemical

reaction is known as combustion which happens when fuel or other material reacts constantly with oxygen, giving off light, heat, and flame. Flame generally consists of carbon dioxide, water vapour, oxygen, and nitrogen. A flame that is produced during the ignition point and in the combustion reaction is said to be the visible and gaseous part of a fire. To corroborate this assertion, Adekunle (2018), also added that, fires is produced when a flammable and/or combustible material is combined with a enough quantity of an oxidizer such as oxygen gas when exposed to a source of heat.

Baker (2015), states that, one of the greatest fire risks is smoking as such it should be prevented in buildings and workplace. If not legally prevented, it should be done only in specified areas with bins provided. Hossain and Islam (2018), assert that fire outbreak is cause due to electrical short circuit, cooking/ stove, careless disposal of burning cigarette and match stick, chemical reaction, explosion, mosquito coil, machine/ engine, sabotage, leaked electric wire, necked lamp, thunder and unawareness of the occupants. Smokers' materials such as cigarettes, matches and lighters also caused fire outbreak in buildings (Omahanna *et al*., 2016). Onoyan-usina *et al*. (2017), states that, fire can be cause as a result of arson which is a deliberate form of protest or revenge which may be against others individuals or a group of people or against government. It can also result from kitchen appliances like gas cookers, ovens, electric stove, and gas cylinders.

Design method on Fire Prevention Strategies in High Rise Building

Fire prevention strategies are methods of preventing the spray of fire in a building which includes both active and passive methods. Kurniawan (2018), states that, fire prevention strategies must be considered first when assessing the safety of the occupants in every building and the duration occupants can take to escape before any fire hazard occur should also be put into cognizance.

While passive fire prevention strategies are regarded as very important fire protection components of structural system and fire safety in a building, it is an attempt to delay the spread of fire(s) using fire–resistant walls, floors and fire rated doors. These building materials are expected to be present and readily available within the building and should be evenly located in every floors of the building .having said that, no mechanical device is required in the operation or application of these materials (Kalidasan, 2017). Some of the passive fire prevention strategies include the following:

Table 1 shows the various suggestions by multiple authors on the design principles that can be adopted to prevent the spread of fire in buildings.

Therefore, the researcher used the following established variables to access the high-rise buildings in Lagos Nigeria to determine their level of fire prevention design principles adopted.

1. Fire egress: This is an act of exiting from the building during a fire to ensure safe evacuation of occupants from the building.
2. Form of the building: Form of the building determined the spread of fire. Simple building is easier to protect from wild fire and those not trap fire's heat while Complex building form in the contrary increase the surface area of the structure and create shapes that trap the fire's heat.
3. Shape of the roof: Roofs are significantly influenced by embers in a wind-controlled fire. A simple roof form such as a hip or straight gable is the best in preventing fire while a complex roof traps the fire's heat.
4. Building structural fabrics: Building structural fabric is required to continue to support its load during a fire.
5. Fire prevention strategies: Fire prevention strategies are measures of preventing fire from spraying in buildings especially high rise buildings.

Table 1: Observed variables

S/N	VARIABLES	AUTHORS AND YEAR	CITATIONS	REMARKS
1	Fire egress	Spearpoint and MacLennan (2012)	Fire egress is an act of exiting from the building during a fire. The essence of providing a means of egress is to ensure safe evacuation of all occupants to a place of safety within a reasonable period. Evacuation process of high-rise building is always affected by the features of the vertical egress components, this includes exits, exits discharge, exit chute system, exits access and access means of egress	The statement indicates that fire egress is essential for safe evacuation
2	Fire Egress	Nilsson (2014)	Modern egress design should take into cognizance variables such as the change of occupant demographics. Occupant behaviours, the technology advancement and subsequent increase in the building height should be considered. Egress components include stairs, escape elevators, area of refuge.	The fire egress is affected by occupant's behaviour, demographic, building heights and advancement in technology
3	Form of Building	Bueche (2012)	Simple forms of building. Complex building forms as name implies are structurally complex but have more surface area relative to volume. Simple building forms on other hand, is regarded as one of the fire prevention strategies as it is easier to protect from wildfire(s), the surface of it exterior is simple to protect and less expensive to build. Complex building form in the contrary increase the surface area of the structure and create shapes that trap the fire's heat (heat traps).	Form of building also affect the spread of fire
4	Shape of the Roof	Bueche (2012)	Roofs are greatly influenced by embers in a wind-controlled fire. A simple roof form such as a hip or straight gable is the best in preventing fire. The use of complicated roofs will further highlight the importance of a truly ignition-resistant roof.	This indicates that the shape of the roof affects the spread of fire in the building
5	Design and Structural Integrity	Omahanna *et al.* (2016)	Building structural fabric is required to continue to support its load during a fire. However, fire has an adverse effect on the performance of the structural elements. Fire proofing, inbuilt fire ratings and proper interconnection of the structural elements help to increase building structural integrity.	The statements show that the design and structural integrity affects the time the building can withstand fire
6	Fire Prention strategies	Guo (2012)	Fire prevention strategies are measures of preventing fire from happening in buildings especially high-rise buildings.	This indicates that fire prevention is very significant in assessing the safety of the occupants
7	Fire Prention Strategies	Kurniawan (2018),	fire prevention strategies must be considered first when assessing the safety of the occupants in every building and the duration occupants can take to escape before any fire hazard occur should also be put into cognizance.	These are things to put into consideration while designing and construction
8	Compartmentation of Fire	Barker (2015)	When buildings are divided into compartments and enclosed in fire-resisting construction, it will provide passive fire protection by inhibiting the spread of fire within the building. In addition, to obey the local building regulations, there is need to limit the size of individual compartments	What determined the compartment size is the overall size of the building, the number of storeys, and the position of

				automatic sprinkler system.
9	Fire resistant materials	Kalidasan, (2017)	And Fire-resistant materials are attempt to delay the spread of fire(s) through the use of fire–resistant walls, floors, materials and fire rated doors. These building materials are expected to be present and readily available within the building and should be evenly located in every floors of the building. having said that, no mechanical device is required in the operation or application of these materials	These are materials that resists fire
10	Fire resistant materials	Outinen (2012)	There are various fire protective cladding materials that are used to join steel girder and column together in order to protect them from fire. Such materials include concrete, gypsum or masonry fire-rated floors, walls or ceilings work as fire barricades.	There are materials that can withstand fire

6. Compartmentation of fire: compartmentation of fire is a way of dividing building into compartments and enclosed in fire-resisting construction.
7. Fire resistant materials: These are building materials that are used to resists fire from the building.

METHODOLOGY

Qualitative research method was used for this research because of the aim of the research which is to access the current levels of design principles adopted in high rise building design in Lagos state, Nigeria, the aim of his research calls for an observation of current practices and trends and using the data collected to make inferences, which is the sole purpose of qualitative research method.

Survey research design was used in this research, it is a form of research where data is collected from samples to make inferences about a population, and it is used to study attitudes and opinions. The study area of this research is Lagos Nigeria, and the building type under research is High rise condominium. Purposeful sampling was used which is a procedure where researchers intentionally select individuals and sites to learn or understand the central phenomenon (Creswell 2012), this was adopted to aid the researcher in collecting relevant data from the case studies as pertains to the subject under research, the case studies were chosen based on the criteria of High-rise condominium buildings in Lagos state. 11 buildings were selected to be used as case studies for this research as sew in table 2, with at least one building from each of the 6 zones of Victoria island, Lagos, which was chosen because of the high density of high-rise buildings in that location, the selection of the buildings was purposeful with the researcher making the decision based on the ability of the buildings to provide the necessary data.

Observation schedule was used for this research because of the research design that was adopted, which requires an observation of trends of the various established variables. Primary Data was collected from the field based on the developed variables using the observation schedule developed by the researcher. The data was organized using codes that were assigned to each variable identified in the literature review. The organized data was analyzed manually via content analysis which involves a researcher quantifying and analyzing the meaning of words or text and making inferences from it (CSU 2004)

Table 2: Lists of high-rise residential buildings selected in Victoria Island Lagos

NAME OF THE BUILDING	TOTAL NUMBER OF UNIT IN THE BUILDING	TOTAL NUMBER OF UNIT IN THE BUILDING	NUMBER OF QUSTIONNAIRE DISTRIBUTED	NUMBER OF QUSTIONNAIRE RETURNED
Eden Height	27	3	14	9
Vita Tower	44	5	22	17
Eko Court Tower	155	17	79	70
Olympic Tower	25	3	13	10
Bar Beach Tower	108	12	55	47
Visage Tower	21	2	11	9
Pier Harbour	16	2	8	5
Aqua Tower	30	3	15	11
Genbrite Complex	15	2	8	5
1004 Apartment	126	14	65	54
Grand Orchard	19	2	10	6
Total	586	65	300	243

RESULTS AND DISCUSSION

Data on fire prevention measures that were used in the selected high rise residential buildings was obtained through critical environmental observation of the buildings studied. The availability of fire safety features and their functionality are as shown in Table 3 below which indicates the availability of fire safety measures either active or passive measures, their functionality and whether the building experienced fire outbreak or not. Figure 1 shows the total number of specific fire safety measures observed in all the case studies, it is evident that the fire extinguisher is the most adopted measure of safety while the escape chute system is the least adopted measure.

Tables 3 Availability of Fire Safety Features and Their Functionality

S/N	Name of the building	Availability of fire safety features in the building	Functionality of the fire safety features	Fire outbreak experienced in the building
1	Eden Height Tower	Adequate	Very functional	None
2	Vita Tower	Moderate	Functional	None
3	Eko court Tower	Moderate	Very functional	None
4	Olympic Tower,	Moderate	Not functional	None
5	Bar Beach Tower	Moderate	Not functional	Yes
6	Visage Apartment	Adequate	Functional	None
7	Pier Harbour	Adequate	Very functional	None
8	Genbrite Complex	Adequate	Functional	None
9	Aqua Tower	Moderate	Not functional	None
10	1004 Apartment	Moderate	Functional	Yes
11	Grand Orchard	Adequate	Functional	Yes

This shows a lack of active design measures in place to aid the prevention of the spread of fire and the reliance on secondary means to achieve that goal. Table 4 shows the design principles adopted per case study to aid the spread of fire; it is evident that most of the case studies averagely applied the design principles.

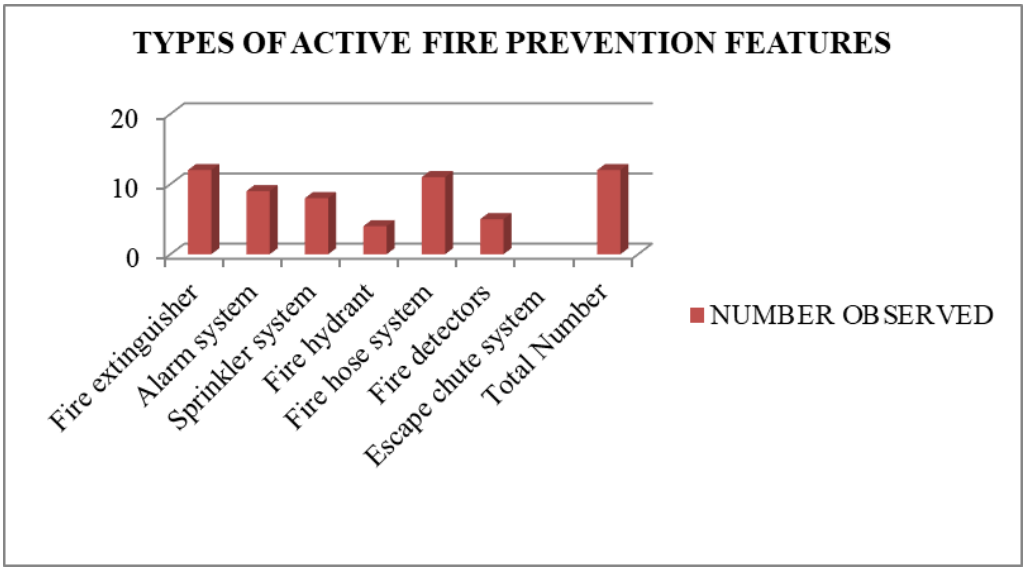

Figure 1: Active fire safety measures in selected buildings

Table 4: Passive Fire Prevention Features in Selected Buildings

S/N	Name of the building	Building form	Shape of the roof	Types of fire resistance materials applied	Types of wall materials	Types of roof materials	Types of materials used for Floor finishes
1	Eden Height Tower	Simple	Simple	Cementitious product, intumescent coating and gypsum board	Hollow block, granite, cladding and wood	Aluminium and concrete	Marble tiles, granite and wood
2	Vita Tower	Simple	Simple	Cementitious product	Hollow block	Aluminium and concrete	Marble tile and wood
3	Eko court Tower	Simple	Simple	Cementitious product	Hollow block	Concrete	Marble tiles and wood
4	Olympic Tower,	Simple	Simple	Cementitious product	Hollow block	Aluminium and concrete	Marble tiles and wood
5	Bar Beach Tower	Simple	Simple	Cementitious product	Hollow block	Aluminium	Marble tiles
6	Visage Apartment	Simple	Simple	Cementitious product	Hollow block	Aluminium and concrete	Marble tiles and wood
7	Pier Harbour	Simple	Simple	Cementitious product	Hollow block	Aluminium and concrete	Marble tiles and wood
8	Genbrite Complex	Simple	Simple	Cementitious product, and gypsum	Hollow block	Aluminium	Marble tiles and wood
9	Aqua Tower	Simple	Simple	Cementitious product	Hollow block	Aluminium	Marble tiles
10	1004 Apartment	Simple	Simple	Cementitious product and Gypsum board	Hollow block, tilling and wood	Concrete and aluminium	Marble tiles
11	Grand Orchard	Simple	Simple	Cementitious product and Gypsum board	Hollow block, tilling and wood	Concrete and aluminium	Marble tiles

Summary of Findings

1. 3/11 (27%) of the buildings have experienced fire outbreak in the past.
2. 9/11 (81%) have functional fire prevention strategies in place.

3. The fire extinguisher is the most adopted method of fire prevention.
4. Most of the buildings adopted simple building forms, simple roofs, and the use of fire-resistant materials, which are all design strategies for fire prevention as stated in table 1.0.
5. Fire prevention strategies is achieved with combination of both active and passive means.
6. Shape of the roof and building forms affect the spread of fire in buildings so careful consideration should be taken in their design.

CONCLUSIONS

Majority of the buildings in Lagos state have functional fire safety measures in place, however there are a select few that are lacking, there is also a need to diversify in the fire prevention strategies put in place to reduce the reliance on fire extinguishers majorly. There is an apparent lack of fire escapes which could be hazardous for human lives and thus future building should be designed with this consideration while existing building scan be retrofitted to adopt it.

RECOMMENDATIONS

1. Means of egress should be provided in buildings. It should be unobstructed and clear.
2. compartmentation of fire prevents the spread of fire to another buildings.
3. The structural fabrics and elements should be able to withstand fire for a limited time frame Shape of the roof and building forms affect the spread of fire in buildings, therefore adequate testing must be done before they are allowed into the public space.
4. Manufacturers of building materials should be encouraged production of building components that are fire rated and selling them to prospective developers at affordable prices.
5. Architects should obey the building regulations and to incorporate the design methods or passive strategies to limits the spread of fire in the buildings.
6. Awareness, education, and information to increase cautiousness of occupants on fire risks and they should be train on how to use extinguisher and also on safety techniques to take during fire outbreak.

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Evaluation of Factors Influencing the Adoption of Building Information Modelling for Facility Management in Abuja, Nigeria

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Abstract
Previous studies have shown that very little research have been on the implementation of BIM in each of the application areas of Facilities Management (FM). These pose challenges for the effective management of facilities. This study therefore evaluated the factors influencing the adoption of BIM for FM in Abuja, Nigeria with a view to improving the adoption of BIM in FM. In view of this, a quantitative research approach was employed for the study. Data were collected from 356 randomly selected construction professionals in Abuja with the use of structured questionnaire. The data collected were analysed with the use of frequency count, percentage and Mean Item Score (MIS). Results of data analysis revealed that the factors influencing the adoption of BIM for FM are important (Group MIS = 3.87); the drivers to the implementation of BIM for FM are important (Group MIS = 3.99); the level of BIM awareness in all the FM application areas in Abuja is high (Group MIS = 3.72); the level of BIM implementation in the FM application areas is high (Group MIS = 3.52) but requires more improvement; and the most effective measures for enhancing the adoption of BIM for FM are Incorporation of BIM to academic curriculum and Embarking on intensive awareness of BIM by software vendors and training institutes (MIS = 4.22 each). It was concluded that the factors influencing the adoption of BIM for FM in Abuja are important and requires to be put into consideration for the successful management of facilities. It was thus recommended that stakeholders should work collaboratively to set up a mechanism for the effective implementation of the measures for enhancing the adoption of BIM for FM. This will in turn enhance the level of adoption of BIM for FM and hence the successful management of facilities.

Keywords: *Facilities Management, Building Information Modelling, Implementation, Adoption.*

INTRODUCTION

Building Information Modelling (BIM) application in the Facility Management (FM) sector is drastically lagging behind those of design and construction phases; hitherto a scarcity of research studies has been carried out on BIM in FM. Also, the merits derived from the involvement of FM from the design stage have been well researched (Chong *et al*., 2014; Nicał & Wodyński, 2016). Furthermore, there have been many studies on the implementation of BIM for FM in several countries of the world. Anifowose *et al*. (2018) revealed that BIM adoption in Nigeria is at its infancy stage because majority of the knowledge of BIM is only in theoretical form. Similarly, Olapade and Ekemode (2018) stated that there is low level of awareness of BIM for FM in the Nigerian construction industry and this have large effect in the implementation of BIM for FM in the construction industry.

Ryal-Net and Kaduma (2015) and Akerele and Etiene (2016) established that there is low level of awareness of BIM in the Nigerian construction industry. Jordani (2010) revealed that 85% of the life cycle costs of a facility occur at the post construction stage. Similarly, the National Institute of Standard and Technology (NIST) (2002) revealed that two third of a sum of $15.8billion lost annually is borne by the owners and operators with the majority occurring during the post construction stage (Anderson *et al*., 2012). These show that the facility management is an important aspect of a building lifecycle, and application of BIM is of immense benefits. The BIM application in FM still holds lot of undeveloped opportunities (Liu & Issa, 2013; Korpela & Miettinen, 2013).

The BIM model which contains life-cycle data about the building information is of immense advantage to the facility managers, as it would enable them to carry out their responsibilities with more than enough information at their fingertip (Ashcraft, 2008; Eastman *et al*., 2008;

Lee *et al*., 2012). There is growing interest in the use of BIM in FM (Becerik Gerber *et al*., 2011). BIFM (2012) reported that it was agreed upon that having building information through BIM holds immense benefits to the facilities managers; and it would make the maintenance easier, improve collaboration, and saves time and cost. The application of BIM in FM practices is still lagging behind that of design and construction (Akcamete *et al*., 2010; Fuller, 2010; Construction, 2012; Liu & Issa, 2013; Brooks & Lucas, 2014). This could be attributed to the lack knowledge and expertise of how the BIM is of benefits and lack of demand by the owners/clients (Mayo *et al*., 2012; Aibinu & Venkatesh, 2013; Brooks & Lucas, 2014). These pose challenges for the effective management of facilities. In order to address this problem, this study evaluated the factors influencing the adoption of BIM for FM in Abuja, Nigeria with a view to improving the adoption of BIM for FM. In order to achieve the aim, the objectives of the study were to: identify and examine the factors influencing the adoption of BIM; evaluate the drivers to BIM implementation; determine the awareness level of BIM for FM; establish the level of BIM implementation in FM application areas; and suggest measures for improving the adoption of BIM for FM in Abuja, Nigeria.

Factors Influencing the Adoption of BIM for FM in the Nigerian Construction Industry

It is a known fact that all of the perspectives of the BIM model highlight its significance in using it for the entire lifecycle of building projects, though scholars defined BIM differently, but its advantages support its application in project facilities management. The use of BIM is being considerably identified across all phases of project life cycle (Shou *et al*., 2015). While advantages and the beneficial deliverables of BIM has become evident, it is worth mentioning that most scholars had oriented their research on the design-construction phases instead of the facility management in its entirety.

Therefore, integrating BIM into FM is facing certain challenges which act as barriers to BIM adoption, particularly in building construction industry. Kassem *et al*. (2015) pointed out the existence of two factors creating difficulties that prevent BIM adoption in FM applications. First, the various stakeholders of the project do not intend to collaborate during modelling or in optimum utilization of the BIM model, and second, lack of awareness by clients which is aggravated by the shortage of BIM skills and absence of understanding by finance management professionals. This is therefore a major challenge for the reason that for the building itself, as well as its owners, BIM processes and models in use, need sustained efforts by facility managers so that they remain effective.

Onungwa *et al*. (2017) discovered that there is low level of awareness and technical know-how of BIM in Nigeria. This was linked to lack of adequate BIM training and inadequate exposure to BIM concept; Inaccessibility to suitable technology and framework; Low level of BIM technical know-how and awareness; Individual perception/ point of view; Absence of appropriate BIM guidelines; Industry/working environment; and Initial BIM huge capital outlays. Furthermore, Aldowayan and Dweiri (2020) identified seven (7) major factors influencing the adoption of BIM for FM. These factors are categorised as: Cost-related factors; Employee-related factors; Information-related factors; Project Plan-related factors; Equipment and Technology-dependent factors; Time-related factors; and Operation and maintenance-related factors. All these factors indicate that the whole of a project is at stake if facility managers are not updated with the right information at the right time. Therefore, to maintain the assets in use, Facility Managers are depended on real-time updated data, which is a matter of concern for them, in addition to other related issues such as the which equipment to use, when to phase out, and what to purchase for the project.

METHODOLOGY

This study was carried out using the quantitative research approach. This research was broadly divided into two parts; the first part of this work includes literature survey which was undertaken to provide the background information required for this research while the second part comprise the use of questionnaire to obtain data from construction professionals.

The target population in the study is composed of the Quantity Surveyors, Architects, Facilities Managers, Civil and Structural Engineers, Building Services Engineers (Mechanical and Electrical) and Builders as they are the primary participants who have substantial involvement and responsibilities in FM processes.

There exists high concentration of construction activities on going in Abuja, coupled with increasing construction professionals within the FCT, hence the choice of Abuja as a study area.

Method of Data Collection

Data were obtained with the use of structured questionnaire of the close ended response format. Being a quantitative research approach, a structured questionnaire became imperative as method for collection. The questionnaire was designed on a five-point Likert Scale format. The questionnaire contains six sections. The first section addresses issues concerning the general profile of respondents. The other sections address issues concerning the research objectives respectively.

Method of Data Analysis

The data collected for this study were analysed with the use of descriptive statistical techniques. The use of frequency counts and percentage were employed to analyse the profile of respondents. Mean Item Score (MIS) was employed in order to analyse the data collected on the research objectives. The use of Microsoft Excel was employed to aid the analysis of data in this study. The decision rule adopted for the MIS analysis is shown in Table 1.

Table 1: Decision Rule for MIS Analysis

Scale	Cut-off points	Remarks/ Decision			
	MIS	Importance	Awareness	Implementation	Effectiveness
5	4.50 -5.00	Very important	Very High	Very High	Very Effective
4	3.50 -4.49	Important	High	High	Effective
3	2.50 -3.49	Fairly Important	Average	Average	Fairly Effective
2	1.50 -2.49	Less Important	Low	Low	Less Effective
1	1.00 -1.49	Least important	Very Low	Very Low	Least Effective

Source: Adapted and modified from Morenikeji (2006); Agumba and Haupt (2014); Shittu et al., (2016)

RESULT AND FINDINGS

Analysis of Respondents' Profile

The study collected data from 356 respondents who are professionals in the construction industry. The profile of these respondents is presented in Tables 2 and 3. Table 2 shows that 20.22% of the respondents are Architects; 12.64% are Builders; 14.89% are Civil/Structural Engineers; 19.94% are Quantity Surveyors; 16.85% are Building/Services Engineers; and 15.45% are from other construction-related professions. It can be seen from Table 3 that 8.99% of the respondents are holders of Higher National Diploma; 57.81% are holders of Bachelor's Degree (BSc/BTech); and 32.30% are holders of Master's Degree (MSc/MTech).

Table 2: Respondents' Profession

Profession	Frequency	Percentage (%)
Architect	72	20.22
Builder	45	12.64
Civil/Structural Engineer	53	14.89
Quantity Surveyor	71	19.94
Building/Services Engineer	60	16.85
Others	55	15.45
Total	**356**	**100.00**

Source: Researcher's Field Survey (2021)

Table 3: Respondents' Highest Academic Educational Qualification

Academic Qualification	Frequency	Percentage (%)
HND	32	8.99
BSc/BTech	209	58.71
MSc/MTech	115	32.30
Total	**356**	**100.00**

Source: Researcher's Field Survey (2021)

Results and Discussion on the Factors Influencing the Adoption of BIM

The result of the MIS analysis is on the factors influencing the adoption of BIM summarised in Table 4.

Table 4 revealed the result of the sixteen (6) factors influencing the adoption of BIM for FM identified in this study. The most important factors influencing the adoption of BIM in Abuja are Lack of adequate BIM training and inadequate exposure to BIM concept; Low level of BIM technical know-how; Inaccessibility to suitable technology and framework; Industry/working environment; Lack of policy and standardisation; and Initial BIM huge capital outlays with high MIS values of 4.19; 4.10; 4.09; 4.07; 4.03; and 4.01 respectively. The other factors are also important. These range from Stakeholders do not intend to collaborate in the optimum utilization of BIM model (MIS = 3.52) and Clients' shortage of BIM skills (MIS = 3.98). Except one factor that is fairly important.

Table 4: Factors Influencing the Adoption of BIM

CODE	FACTORS INFLUENCING BIM ADOPTION	MIS	RANK	DECISION
B5	Lack of adequate BIM training and inadequate exposure to BIM concept	4.19	1st	Important
B7	Low level of BIM technical know-how	4.10	2nd	Important
B6	Inaccessibility to suitable technology and framework	4.09	3rd	Important
B10	Industry/working environment	4.07	4th	Important
B13	Lack of policy and standardisation	4.03	5th	Important
B11	Initial BIM huge capital outlays	4.01	6th	Important
B3	Clients' shortage of BIM skills	3.98	7th	Important
B9	Absence of appropriate BIM guidelines	3.90	8th	Important
B4	Absence of understanding by finance management professionals	3.81	9th	Important
B12	Corruption amongst the construction stakeholders	3.79	10th	Important
B8	Individual perception/ point of view	3.78	11th	Important
B15	Non recognition of BIM role by the government and the clients	3.78	11th	Important
B16	Resistance by the industry professionals	3.72	13th	Important
B2	Lack of awareness	3.70	14th	Important
B1	Stakeholders do not intend to collaborate in the optimum utilization of BIM model	3.52	15th	Important
B14	Lack of case study as a precedent (to demonstrate BIM benefits)	3.48	16th	Fairly Important
	Group MIS	***3.87***		***Important***

This is Lack of case study as a precedent (to demonstrate BIM benefits) with MIS value of 3.48. On the average, the factors influencing the adoption of BIM for FM in Abuja are important (Group MIS = 3.87). This result corroborates the findings of Eastman *et al*. (2008); Hardin (2011) and Becerik-Gerber *et al*. (2011). Eastman *et al*. (2008) and Hardin (2011) consider BIM as a tool that offers a solution to the problematic information handling within facility management. While Becerik-Gerber *et al*. (2011) affirmed that in spite of the fact that the greatest influences of BIM has been seen in the design and construction phase, owners have in recent years begun to see the potential benefits even in the buildings later stages. The factors influencing the adoption of BIM for FM are therefore important as they can make or mar the successful management of facilities.

Results and Discussion on the Drivers to BIM Implementation

The MIS analysis on the drivers to the implementation of BIM for FM is summarised in Table 5.

Table 5: Drivers to BIM Implementation

CODE	DRIVERS TO BIM IMPLEMENTATION	MIS	RANK	DECISION
C11	The need for effective facilities management of completed projects	4.23	1st	Important
C13	The need to achieve lifecycle BIM uses	4.19	2nd	Important
C8	The need for timely delivery	4.14	3rd	Important
C4	Reformation of design activities and improvement of design quality	4.07	4th	Important
C12	The need for integrating people, place, processes and technology	4.05	5th	Important
C7	The need to secure more financial savings and monitoring	4.04	6th	Important
C3	Improvement of capacity to provide whole life cycle value to client	3.98	7th	Important
C9	The need for more precise order of construction and clash detention	3.98	7th	Important
C5	Incorporation of health and safety in the construction process	3.94	9th	Important
C2	Urge to meet client's needs and competitive nature of the industry	3.90	10th	Important
C10	Enhancing increased pre-fabrication	3.88	11th	Important
C6	The need to enhance communication with workmen	3.86	12th	Important
C1	Government pressure	3.56	13th	Important
	Group MIS	***3.99***		***Important***

Table 5 shows the result of thirteen (13) drivers of the implementation of BIM for FM as identified from this study. The most important drivers to the implementation of BIM for FM in Abuja are The need for effective facilities management of completed projects (MIS = 4.23); The need to achieve lifecycle BIM uses (MIS = 4.19); The need for timely delivery (MIS = 4.14); Reformation of design activities and improvement of design quality (MIS = 4.07); The need for integrating people, place, processes and technology (MIS = 4.05); and The need to secure more financial savings and monitoring (MIS – 4.04). The remaining drivers to the implementation of BIM for FM are also important. These range between Government pressure (MIS = 3.56) and Improvement of capacity to provide whole life cycle value to client (MIS = 3.98). On the average, all the identified drivers to the implementation of BIM for FM in Abuja are important (Group MIS = 3.99). The result of this study is in line with the studies of Kassem *et al*. (2015) and Onungwa *et al*. (2017) because these studies also gave higher importance to

the most important drivers in this study. For instance, Kassem *et al*. (2015) identified the need for various stakeholders of a project to collaborate during modelling or in optimum utilization of the BIM model, and the need for awareness by clients as the main drivers to enhancing BIM adoption in FM applications. Onungwa *et al*. (2017), on the other hand, discovered that there is a need for improving the level of awareness and technical know-how of BIM in Nigeria. It is therefore imperative to determine the current level of awareness and implementation of BIM.

Results and Discussion on the Level of Awareness of BIM-FM in Abuja

Table 6 presents the result of the MIS analysis on the level of awareness of BIM for FM in twenty-one (21) core FM application areas.

Table 6: Level of Awareness of BIM-FM in the Nigerian Construction Industry

CODE	LEVEL OF AWARENESS	MIS	RANK	DECISION
D21	Technology	3.97	1st	High
D13	Communication; Project Management;	3.96	2nd	High
D1	Design Stage	3.95	3rd	High
D4	Information handling	3.93	4th	High
D20	Real estate and property management	3.91	5th	High
D19	Quality management	3.85	6th	High
D3	Operation / Facility Management Stage	3.76	7th	High
D14	Process/workflow	3.76	7th	High
D2	Construction/Building Stage	3.74	9th	High
D12	Checking maintainability	3.72	10th	High
D18	Leadership and strategy	3.70	11th	High
D15	Emergencies preparedness and business continuity	3.68	12th	High
D5	Strategic management	3.67	13th	High
D11	Visualization and marketing	3.64	14th	High
D17	Environmental human factors	3.64	14th	High
D16	Stewardship and sustainability	3.63	16th	High
D9	Locating building components	3.59	17th	High
D7	Financial Application (rental management, procurement and accounting)	3.57	18th	High
D6	Governance of the resources and services	3.55	19th	High
D8	Technical Application (operation and maintenance of the property)	3.50	20th	High
D10	Facilitating real-time data access	3.50	21st	High
	Group MIS	***3.72***		***High***

Table 6 revealed that the level of awareness of BIM in all the application areas of FM is high. The FM application area with the highest level of BIM awareness is Technology (MIS = 3.97) while the FM application areas with the least level of BIM awareness are Technical Application (operation and maintenance of the property) and Facilitating real-time data access (MIS = 3.50 respectively). On the average, the level of BIM awareness in all the FM application areas in Abuja is high (Group MIS = 3.72). The result of this study here differs from finding from the study of Onungwa *et al*. (2017). This is because Onungwa *et al*. (2017) discovered that there is low level of awareness and technical know-how of BIM in Nigeria. In view of this, it is important to determine the level of implementation of BIM in all the application areas.

Table 7 shows that the level of BIM implementation is high in thirteen (13) of the twenty-one (21) core FM application areas. These FM application areas range from Locating building components (MIS = 3.53) to Technology (MIS = 3.77). On the other hand, the level of BIM implementation is on the average in eight (8) FM application areas.

Results and Discussion on the Level of BIM Implementation in FM Application Areas in Abuja

Table 7: Result of the MIS ranking on the level of BIM implementation in FM application areas in Abuja.

Table 7: Level of BIM Implementation in FM Application Areas in the Nigerian Construction Industry

CODE	BIM IMPLEMENTATION LEVEL	MIS	RANK	DECISION
E21	Technology	3.77	1st	High
E20	Real estate and property management	3.70	2nd	High
E1	Design Stage	3.68	3rd	High
E3	Operation / Facility Management Stage	3.68	3rd	High
E18	Leadership and strategy	3.65	5th	High
E19	Quality management	3.60	6th	High
E4	Information handling	3.57	7th	High
E14	Process/workflow	3.56	8th	High
E15	Emergencies preparedness and business continuity	3.56	8th	High
E12	Checking maintainability	3.54	10th	High
E17	Environmental human factors	3.54	10th	High
E9	Locating building components	3.53	12th	High
E5	Strategic management	3.49	13th	Average
E8	Technical Application (operation and maintenance of the property)	3.49	13th	Average
E16	Stewardship and sustainability	3.49	13th	Average
E13	Communication; Project Management;	3.47	16th	Average
E2	Construction/Building Stage	3.43	17th	Average
E11	Visualization and marketing	3.42	18th	Average
E10	Facilitating real-time data access	3.37	19th	Average
E7	Financial Application (rental management, procurement and accounting)	3.26	20th	Average
E6	Governance of the resources and services	3.15	21st	Average
	Group MIS	***3.52***		***High***

These range between Governance of the resources and services (MIS = 3.15) and Strategic management (MIS = 3.49). On the average, the level of BIM implementation in the FM application areas is high (Group MIS = 3.52). The finding of this study here agrees with findings from past studies to a great extent. This because Marcus *et al.* (2015) that examined BIM in the Nigerian construction industry found that there is a low level of knowledge of BIM which is related to the low utilization among the stakeholders. Also, Olanrewaju *et al*. (2020) found that BIM has been applied to various aspects of construction processes in developed countries but Nigeria is yet to realize the full potentials of BIM. In addition, Babatunde *et al*. (2020) reported that BIM adoptions have not been generally embraced by many Architecture, Engineering, and Construction (AEC) firms, particularly in developing countries. It can be seen from the result of this that in spite of the fact that the Group MIS revealed high level of implementation, some of the FM application areas still have average implementation level and all of the areas have MIS values less than 4.00 on a five – point scale. It is therefore necessary to propose measures for enhancing the level of adoption of BIM for FM. This will bring about improved level of awareness and implementation of BIM for FM.

Results and Discussion on the Measures for Improving the Adoption of BIM for FM in Abuja

The result of the MIS analysis employed to rank the identified measures for improving the adoption of BIM for FM in order effectiveness is presented in Table 8.

Table 8: Measures for Improving the Adoption of BIM for FM in the Nigerian Construction Industry

CODE	MEASURES FOR IMPROVING BIM-FM ADOPTING	MIS	RANK	DECISION
F5	Incorporation of BIM to academic curriculum	4.22	1st	Effective
F9	Software vendors and training institutes should embark on intensive awareness of BIM	4.22	1st	Effective
F17	Government provides an enabling environment for BIM-based process	4.19	3rd	Effective
F1	Collaboration, training and promotion among stakeholders	4.13	4th	Effective
F6	Enactment of BIM guideline and regulation	4.13	4th	Effective
F7	Provision of appropriate technology and infrastructure	4.11	6th	Effective
F10	Developing improved data exchange standards	4.10	7th	Effective
F12	Mandate BIM on public projects	4.10	7th	Effective
F2	Public sector to establish regulatory approval	4.04	9th	Effective
F3	Public sector to remove impediments by building BIM capability and capacity	4.03	10th	Effective
F11	Build trust between professionals	4.01	11th	Effective
F15	Consider government and professional societies as a team to lead BIM implementation	3.97	12th	Effective
F13	Splits the software cost over projects as well as sharing the cost with a client	3.96	13th	Effective
F16	Push-pull strategy between the AEC stakeholders	3.88	14th	Effective
F4	Public sector to incentivize early BIM adopters	3.79	15th	Effective
F14	Customise the local building components for objects libraries	3.78	16th	Effective
F8	Setting up BIM council	3.72	17th	Effective
	Group MIS	***4.02***		***Effective***

Table 8 shows the MIS ranking of the seventeen (17) measures for enhancing the adoption of BIM for FM as identified from the review of literature in this study. It was revealed that all the measures identified are effective. The most effective measures for enhancing the adoption of BIM for FM are Incorporation of BIM to academic curriculum and Software vendors and training institutes should embark on intensive awareness of BIM with MIS values of 4.22 each. The least effective measure is setting up BIM council with MIS value of 3.72. On the average, all the identified measures for enhancing the adoption of BIM for FM in Abuja are effective (Group MIS = 4.02). The result of this analysis is in line with the findings of Alufohai (2012), Poole (2014), Ezeokoli *et al*. (2016) and Hamma-Adama (2020). This is as a result of the fact that Poole (2014) identified collaboration, training and promotion as the way forward for BIM implementation. In addition, Isa (2015) identified strategies for overcoming BIM barriers to include improve BIM awareness and understanding, outsourcing BIM experts, provision of training by employers, provision of BIM education at higher institutions, government legislation supporting the use of BIM, clients demand for BIM, government support, developing BIM guidelines and improved data exchange standards. These measures identified by Isa (2015) are similar to the highest ranked measures in the result of this study. Finally, the studies of Alufohai (2012), Ezeokoli *et al*. (2016) and Hamma-Adama (2020) also supported these findings. It is therefore important to come up with recommendations for ensuring the effective implementation of measures to overcome barriers in implementation of BIM.

CONCLUSION AND RECOMMENDATIONS

The study found that Lack of adequate BIM training and inadequate exposure to BIM concept; Low level of BIM technical know-how; Inaccessibility to suitable technology and framework;

Industry/working environment; Lack of policy and standardisation; and Initial BIM huge capital outlays are the most important factors influencing the adoption of BIM for FM in Abuja. The most important drivers to the implementation of BIM for FM in Abuja are The need for effective facilities management of completed projects; The need to achieve lifecycle BIM uses; The need for timely delivery; Reformation of design activities and improvement of design quality; The need for integrating people, place, processes and technology; and The need to secure more financial savings and monitoring. These drivers are important to the successful adoption of BIM for FM. The level of BIM awareness in all the FM application areas in Abuja is high. The level of BIM implementation in the FM application areas is also high but requires improvement for the successful management of facilities in Abuja. Incorporation of BIM to academic curriculum and Software vendors and training institutes should embark on intensive awareness of BIM are the most effective measures for enhancing the adoption of BIM for FM. It can therefore be concluded that the factors influencing the adoption of building information modelling for facility management (BIM-FM) in Abuja are important and requires to be put into consideration for the successful management of facilities.

In view of the findings and conclusion of this study, it is strongly recommended that sstakeholders in the construction industry and facility managers should adopt the strategies of incorporating BIM to academic curriculum and organising intensive awareness programme on BIM to improve the level of adoption of BIM. The study also recommends that in order to improve the level of awareness and implementation of BIM for FM, stakeholders should work collaboratively to set up a mechanism for the effective implementation of the measures for enhancing the adoption of BIM for FM. This will in turn enhance the level of adoption of BIM for FM and hence the successful management of facilities.

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Assessment of Shared Parking in Mixed-Use Buildings in Kano State

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Abstract:

Right from time, man has been a wanderer moving about in search of food and shelter. Building as a shelter is as old as man, also different buildings perform different functions or uses to man. Some buildings have a single function, while others serve multiple functions or purpose known as 'Mixed-use building'. One major problem encountered with these types of structures is the issue of parking, caused as a result of either; the design, the users of the building, or standard laws (rules and regulation) guiding the location. This study aims at assessing the importance of shared parking space as a solution to parking problems in mixed-use buildings. Purposive Sampling Method was employed, where the sample population to be studied were selected and data was collected through questionnaires and personal observation. The study concluded that shared parking is the best means of achieving an efficient and sustainable parking space in a mixed-use building or development. This can be achieved through the provision of the right parking spaces to the functions performed as well as proper planning during the design stage. Also, the issue of shared parking in order to reduce too much usage of scarce land for parking lots should be well planned. Analyses of the quantity of the parking spaces provided, estimating the average number of car users', and ascertaining the user's perception on the parking lots provided.

***Keywords**: Building, Mixed-use, Parking, Shared parking, Shelter*

INTRODUCTION

Mixed-use developments or communities have been in existence as far back as the medieval period, when their villages were incorporated with different functions at the same location. Cities arising from the development of these villages exhibit some features of a mixed-use community or development. According to Litman (2012a), the benefits of this type of structures can "create more accessible, multi-modal, efficient and liveable communities. People who live and work in such communities tend to drive less and rely more on alternative modes than in more automobile-dependent locations". After a survey of individuals, it was discovered that there is some evidence that this kind of development pattern may be preferable to many residents. It was also found out that overall neighbourhood satisfaction is actually higher among those living in traditional neighbourhood style developments than in suburban neighbourhoods (Lovejoy, *at el.*, 2010).

According to Niemira (2017), a mixed-use building is a real estate development projects that is well organized and integrated with either the combination of shops, offices, residents, restaurant and other facilities. The building is pedestrian-oriented and has features of live-play-work area. This enhances maximum utilization of space, provides infrastructures, architectural manifestation and also reduces congestions on the road. Urban centres are now extremely interested in this type of development. This is because it provides maximum comfort and aesthetically pleasing environment. The different functions incorporated must be complementary of each other, and at the same time an entity on its own when it comes to marketing. Anders (2014), portrayed mixed-use communities as incorporated developments merged by distinguishable path and outlined public spaces.

In the last 20 years, there has been a rise in global interest in economic, social and environmental sustainability (Walker, 2013). This interest is led by the New Urbanism movement which promotes enhanced community life and reduced vehicle travel through neighbourhood design and environment. This development strategy is termed 'smart growth' as opposed to 'sprawling' developments in suburban communities.

Gentry (2015), on the other hand stated the advantages of this type of development as its being convenient and a comfortable provision of a live-play-work and retail/commercial environment. The community offers the retailers the chance to operate in a conducive and marketable environment, thereby resulting to increase in sale. The development is advantageous to the developers because the diversified nature of uses placed in one location reduces their investment risk (Child, at el., 2006). Mixed-use development is becoming more popular among businessmen and developers because research has it that the development has continued to overshadow sub-urban real estate, in terms of commercial and office space lease rates, retail patronage and also in hotel accommodation demand, also this type of development allows the city planner and urban designer to create a liveable, safe and exciting community (Coupland, 2017).

Retailers and investors see the value of mixed-use developments because studies have shown that these developments consistently out-perform suburban real estate in office and retail lease rates, in retail sales, and in hotel room occupancy rates. For retailers, mixed-use developments provide the opportunity to locate their business in an area with positive demographics and this leads to higher sales (Gentry, 2015). For city planners and urban designers, a mixed-use area is used as a foundation for a lively, safe and interesting neighbourhood (Coupland, 2017).

Mixed-use developments are also appealing to part-time residents. To traveling professionals and traveling couples with family in other parts of the world, the size, location and visibility of mixed-use developments is highly desirable (Coupland, 2017). Full-time and part-time residents can maintain the smaller, upscale residences and have the additional benefit of close access to entertainment, shopping and work (Gentry, 2015).

Another important feature of this building is that, it ensures maximum utilisation of the parking facilities or spaces. Due to the premiun nature of the land, and the increase in the demand for it, this type of design will serve as a solution for the rapid demand of development (Lund, 2013). Levitt and Schwanke (2013), state that "parking is an integral component of most mixed-use developments and can significantly affect the project's overall operational efficiency, image, and success". This is because the different needs for the parking spaces by the different functions differs, that is, at different time of the day and sometimes weekends.

One of the major problems associated with mixed-use buildings is the issue of parking. Parking is vital in a mixed-use development. It is an important factor due to its extremely costly nature. The parking facility will always add to the investor's cost. Also, it takes away valuable scarce land resources from the site. Even with this, it is a necessity that they must be provided. Although, in some places viable mass transits are provided, these developments still demand for a large committed parking lot. The demand for this type of Buildings is on the increase every day.

Kano which is one of the fastest growing cities, located in the northern part of the country is becoming overpopulated at an alarming rate. This is due to the fact that it is the centre of commerce and the influx of people into the city is increasing every day. The demand for buildings in and around the city is on the increase, while the land to cater for this development is fast becoming scarce. This chapter aims at assessing the importance of shared parking theory to mixed-use buildings in Kano State as a solution to parking problem. This can be achieved through analysing the quantity of the parking spaces provided, estimating the average number of car users', and ascertaining the user's perception on the parking lots provided.

It is not an easy task to design a mixed-use building and style it to operate as a singled-use building. Design or operational errors are encountered more in this type of development. The combination of the right functions is of paramount importance. Providing an efficient parking facility is not an easy task in this type of building. The parking plan should be made possible

to meet-up with every applicable codes and ordinances, while bearing in mind that neither the parking requirements for the different users nor the functions are the same, due to their different time of functioning. Example; the parking space used by the office users during the daytime is available to be used at the night by other users (restaurants, residential, theatre), through shared parking theory.

Problems with Typical Parking Space Planning in Public Buildings

The result of these growth patterns and the uncertainty in planning for parking space has been that, for decades, the problem of suburban sprawl has been one of much discussion both in the academic literature and in practice, it is safe to say that Cervero (2018), was correct when he stated in his article on suburban mixed-use that "suburban traffic congestion has emerged as one of the most pressing problems in the transportation field today and, most probably, will hold centre stage in the transportation policy arena for years to come." In his article also, Cervero (2018), again criticized the traditional suburban development patterns that consist of single-use centres that, in contrast to varied and well-designed urban centres, require high levels of private vehicle use to get from place to place.

The Concept of Shared Parking

Shared parking is the process of using one parking facility or space by multiple users. It is a parking that serve different users, by taking advantage of their different peak parking periods that varies during the day, week or season. It is also a set of schemes used in a neighbourhood to decrease the amount of new parking areas required in a project. One of the benefits of clustering different uses together, even when the development occurs within an otherwise dispersed suburban environment, is the opportunity for those uses to share parking (Cervero, 2018; Litman, 2012c).

Importance of Shared Parking

It is a parking that serves different users, by taking advantage of their different peak parking periods that varies during the day, week or the season. It is also a set of schemes used in a neighbourhood to decrease the amount of new parking areas required in a project. .

Figure 1 illustrates how the Chicago Metropolitan Agency for Planning (2012) provides the differences in parking demands for shared parking schemes. The figure clearly shows how significant parking savings can be when shared among uses based on a need per time period, rather than required for each separate use based on the absolute maximum number of spaces needed during that use's peak time. This means that the theory can reduce the overall parking spaces required by the structures.

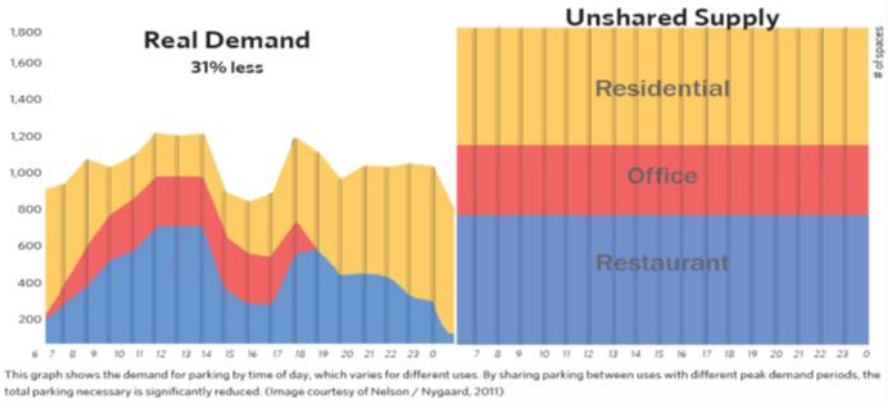

Figure 1: Potential paces saved using shared parking vs. unshared
Source: Chicago Metropolitan Agency for Planning (2012).

The importance of this type of parking in the community is numerous; provision of free spaces for productive usage (new businesses, recreational areas) through a decrease of the parking spaces provided, the encouragement of the use of public transport that are environmentally conducive and friendly such as mass transit or bicycles due to less parking. It also allows investors to build different kinds of buildings/developments at a less cost using a flexible tool for parking (Marshall & Garrick, 2012).

Forms of Parking

The location of parking spaces provided is also a concern in mixed-use structures, since the placement of spaces can directly influence the walkability and the beauty of a development. Litman (2012), suggests a hierarchy of forms of parking provided in mixed-use building/developments:

i. On-street parking on main commercial streets (it is best if regulated, using either pricing or time limits, for maximum turnover);
ii. Off-street public parking/additional on-street parking; and
iii. Off-street private lots (can still be shared between two uses with opposite peak hours, i.e. a bar and a church).

Study Area

Kano municipal or Kano city which is the capital of Kano State is the study area for this research. The city is located along latitude 8°31'E and longitude 12°00'N. It is the study area because these types of structures are found mainly in the state capital. Figure 2 is a map of Nigeria showing the location of Kano State.

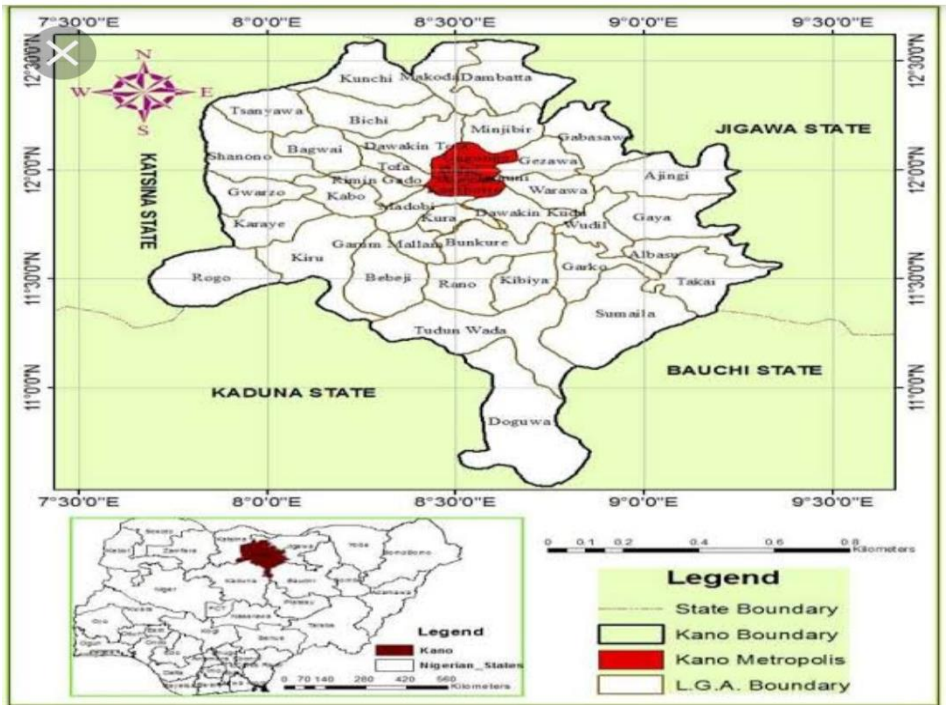

Figure 2: Location of Kano State in Nigeria
Source: Researchgate (2019)

Six different mixed-use buildings were sampled and selected for the purpose of the research. They are;

1. Ummi Plaza.
2. Dogon Banki Building.
3. Gidan Ado Bayero.
4. Zainab House.

5. 7C Building.
6. Hafsatu House.

METHODOLOGY

The methodology employed involves a purposive sampling method, where the sample population to be studied were selected due to the mixed-use criteria met by the selected buildings. Data was collected through questionnaires and personal observation. To assess the problem of parking spaces in a mixed-used building in the state, information were gathered from primary and secondary data. The primary data were obtained through personal observation and questionnaire administration. 120 questionnaires were administered to shop owners and users in equal ratio to all the six locations, out of which only 102 questionnaires were retrieved and valid. Data collated were analysed through the use of bar charts, tables and content analysis. The data collected for the study were collated and organized into tables and graphs with each sample frame treated as an entity. The analysis of the data was carried out through cross tabulation of the variables in order to find out if there is any relationship among the variables. Method of data collection for the research was through oral interview, observation schedule and questionnaire administration. Also, stratified random sampling technique was used for the research.

DISCUSSION OF RESULTS

Analysing the quantity and sizes of the parking spaces provided

The parking spaces in all the selected buildings were studied and the result is shown in the Table 1.

Table 1: Parking Space Sizes and Quantities in Kano State Mixed-used Buildings

Mixed-Used Buildings	***No. of Uses / Functions***	***Size of parking lot (m2)***	***No. of Parking Spaces Provided***	***No. of Parking Spaces Required***
Ummi Plaza	65	1050	60	189
Dogon Banki	34	8400	480	320
Gidan Ado Bayero	50	7875	450	420
Zainab House	14	350	20	67
7C Building	32	87.5	5	68
Hafsatu House	17	787.5	45	46
TOTAL	**212**	**18550**	**1060**	**1110**

From Table 1, it can be seen that Ummi Plaza with the highest number of uses (functions), had only 60 parking spaces being provided. While, Zainab House with the least number of functions had 20 been provided and is not adequate. It can be deduced that special consideration was not given during the design stage of some of the mixed-use buildings. As a result of this, problems of parking are encountered at these locations. The sizes of the parking spaces are not in ratio with the number of functions presence in the buildings.

Plate 1: Ummi Plaza

Plate 2: Zainab House

Plate 1 and 2 show Ummi plaza and Zainab House mixed used development respectively, the parking facilities can be seen also, though scanty since it's an off peak period.

Estimating the number of car users'

The quantity of users of these mixed-used buildings with cars and also the guests users' with cars were estimated over a period of a week, a constant figure is shown in table 2, the number of cars during a peak period. The numbers include even such cars that are parked on the road by employees and customers due to inadequate parking spaces on the site.

Table 2: Number of Car Users

Mixed-used Buildings	***Employees***	***Guests/Customers***	***Total***
Ummi Plaza	73	101	174
Dogon Banki	65	82	147
Gidan Ado Bayero	60	161	221
Zainab House	20	62	82
7c Building	38	44	82
Hafsatu House	24	79	103
TOTAL	**280**	**529**	**809**

It can be seen that Gidan Ado Bayero with 221 had the highest number of car users. While the buildings with the least number of car users are Zainab House and 7C Building both having a total number of 82 car users. This implies that Gidan Ado Bayero will require more parking space than the other structures.

Ascertaining the perception of users' on the available parking space

This addresses the responses from the questionnaires administered, the respondents were asked if they had problems with the parking spaces and also with the circulation around the parking spaces. These are presented in the figures below;

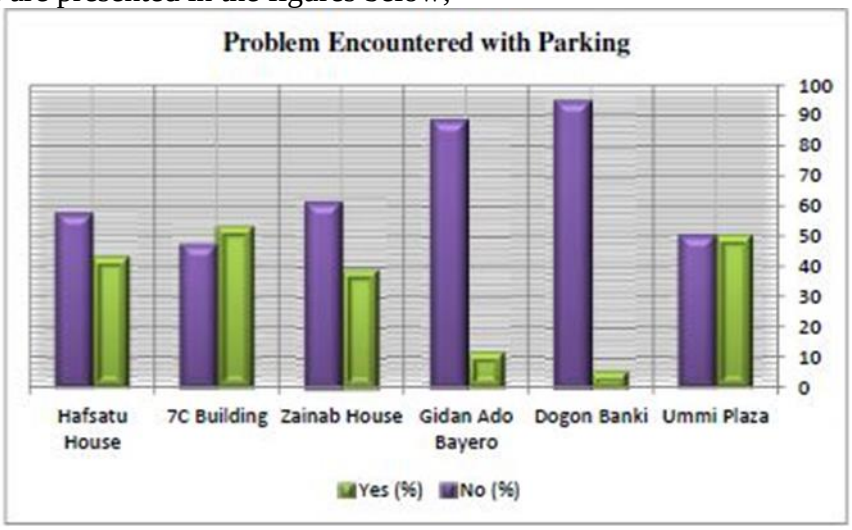

Figure 3: Problems encountered in Parking

From Figure 3, it can be deduced that 7C Building with 52.9% has the highest number of parking space problem, while Dogon Banki with 5.6% encountered the least problem associated with parking space. Majority of the respondents were not happy in places where parking is an issue especially during the peak periods of some functions/uses that clashed together.

Figure 4: Circulation Problems with Parking

Figure 4 from the users' response shows that both Dogon Banki and Gidan Ado Bayero had no problem with respect to circulation in their respective parking spaces. While the highest problem encountered with circulation is Ummi Plaza and 7C Building with 77.8% and 64.7% complaint rate respectively, Hafsatu House has 57.1% of the respondents complaining of circulation, while Zainab House has a complaint rate of 44.4%, which so far is the lowest complain rate.

CONCLUSIONS

From the analysis carried out, the results showed that most of the parking spaces studied in the selected mixed-use buildings were not adequate. This is due to the insufficient parking spaces when compare with the different functions available in the buildings, in the case of Ummi Plaza, Zainab House and 7C Building. Factors causing insufficient parking spaces were ascertained, analysed and discussed in a bid to actually determine the causes of inadequate parking spaces in mixed-use buildings. It is of utmost importance to achieve a balance between the different functions that are incorporated in mixed-use buildings (uses/functions that have different peak periods should be encouraged). This is necessary in order to achieve a successful share parking principle in the building. This will make sure that the actual number of parking spaces required is reduced by a certain percentage. Also, scarce land will be fully utilised and wastage will be minimised.

The study had successfully shown that, most mixed-use buildings have parking space problems. The problem may arise either due to the investors quest for profit (building up the whole site without provision for parking space), as is the case of 7C Building. While some of the buildings have insufficient parking spaces (Ummi Plaza & 7C Building), some have sufficient and well defined parking spaces (Dogon Banki & Gidan Ado Bayero). The chapter in conclusion, recommends various means of achieving an efficient parking space in a mixed-use building or development, such as;

i. Provision of the right ratio of parking spaces to the functions that are performed in the building be determined during the design stage.
ii. Also, the issue of shared parking in order to reduce too much usage of scarce land for parking lots should be well planned.
iii. Functions that have the same peak periods should be avoided as much as possible when planning a mixed-use building.

When building new mixed-use developments, attention to convenient location, outdoor shopping, atmosphere, interconnecting sidewalks and adequate parking could assist in the future success of the development. Some of these attributes are subjective, but attention to creating a unique experience is paramount. For example, creating atmosphere can be accomplished through development design, architecture, and landscaping.

As a retail owner, town centre development attributes should be considered before deciding to locate in a mixed-use development. For example, the mix of stores, adequate parking and convenient location should all be examined to identify the impact each attribute could have on the success of the development. A retail owner can also influence each of the store attributes through the company goals and policies. Care should be taken to identify and meet the needs of consumers in areas such as product quality, up-to-date items, and no hassle return policies.

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Influence of Urban Recreational Facilities Quality on Domestic Urban Tourists Patronage of Parks in Abuja City, Nigeria

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Abstract:

Quality of facilities in urban parks are essential to tourism development in cities. Ironically, the state of facilities in urban parks are often not accorded adequate academic attention in some developing countries including Nigeria. Thus, this paper examines the effect of parks facilities quality on patronage of urban tourists in Abuja. Four parks namely: Millennium Park, Magic Land, Jabi Lake Park, and Tobix Garden were chosen for this study. 500 questionnaires were administered to domestic tourists who were conveniently selected in the parks and 320 questionnaires were filled and returned. Firstly, frequency of visit was determined, then the quality of facilities was measured, and followed by the effect of facilities quality on tourists' patronage using descriptive analysis and chi-square analysis in SPSS version 20. The finding of this study revealed that majority of tourists visit the parks once in a week. While majority of the tourists rated the facilities in the parks to be of high quality, in good condition, only the toilets were rated negatively low. Furthermore, the findings of the study indicate that only walkways and access roads significantly and positively influence patronage of parks, while poorly maintained toilets significantly and negatively influence patronage of parks in Abuja city. The paper recommends that all facilities in parks in Abuja city should be properly and regularly maintained to enhance increased patronage.

Keywords: Tourism development, Urban Park, Facilities, Patronage, Abuja.

BACKGROUND OF THIS RESEARCH

In today's dynamic and rapidly changing digital world of all-round social changes primarily led by the scientific and technical progress, everyone needs time for recreation, which can be understood as the activity a person takes part in for pleasure or relaxation rather than as work (Elegbeleye, 2005). The desire to seek rest in form of leisure is often sought by both international and domestic tourists all over the world, and this is one among many reasons' tourists visit recreational parks. This desire can be well fulfilled if a destination provide quality facilities and are made attractive. The attractiveness of a tourism destination is often referred to the opinions of visitors about the destination's perceived ability to satisfy their needs. Research has shown that attractiveness studies of a recreational and tourists' destination are necessary for understanding the elements that encourage people to travel (Formica, 2002).

The tourism sector offers numerous and diverse opportunities. According to Tahiri and Kovaci, (2017), an individual's selection of the type of holiday depends on their level of education, and income, their environment, interest in culture, living standard and perceived image of the destination in terms of quality of facilities. The assessment of quality of facilities in a tourists and recreation area should be able to look into the examination of aspects such as: aesthetics, cleanliness, safety, general conditions of the site (Cavnar, Kirtland, Evans, Wilson, Williams, Mixon, and Henderson, 2004; Saelens, Frank, Auffrey, Whitaker, Burdette, and Colabianchi, 2006) and social environment within a recreational facility, all of which were found to influence facility use (Ries, Gittelsohn, Voorhees, Roche, Clifton, and Astone, 2008).

Quality is well known as the fundamental determinant that contributes to the success and failure of the service sector (Tabaku and Cerri, 2016; Yusof and Rahman, 2011). Ekinci, Prokopaki, and Cobanoglu (2003) and Akbaba (2006) noted that measurement of quality has been a complex task and has received considerable attention from researchers over the past three decades, thereby causing serious debate in the extant literature about the most acceptable way to conceptualize it. An appealing quality of service often referred to as intangible characteristics provided to tourists tends to develop satisfaction among tourists, enhances the re-visitation rate and generates more income for the destinations (Baksi, 2014; Kwok, Jusoh, and Khalifah, 2016). As important as the tangible aspect of tourism and recreational sites facilities quality measurement is, the concentration of research has been on intangibles characteristics. Thus, in an attempt to bridge this gap, this paper examines the effect of facilities quality on urban tourists' patronage of parks in Abuja city.

RESEARCH METHODOLOGY

A quantitative research paradigm was considered for this study and therefore, a survey research design through the use of questionnaires was used to collect data in four selected urban parks in Abuja city in Nigeria. These parks are Millennium Park, Magic Land, Jabi Lake Park, and Tobix Garden. 500 questionnaires were administered to domestic urban tourists who were in Abuja from other cities in Nigeria for leisure and holidays. These tourists were conveniently selected in the parks and the questionnaires were administered over a period of two months. Because some of the questionnaires were given to the tourists to fill, only 320 administered questionnaires were retrieved, thereby yielding a return rate of 64%. Analysis of questionnaire commenced with data screening for outliers, thereafter, the data was subjected to descriptive analysis (frequency distribution), and chi-square analysis in SPSS 20, and the results were presented in tables.

RESEARCH FINDINGS AND DISCUSSION

In this section, the first analysis result presented is number of visitation to parks by urban tourists weekly. As reported in table 1, it is evident that majority of tourists (64.7%) visit parks in Abuja city once in a week and very few tourists (3.1%) visit the parks three times in a week. The table also show that 31.3% of urban tourists visit the selected parks twice in a week and no tourist's takeout time to visit the parks four and five times a week. The relatively low frequency of patronage is not surprising for tourists as they often have planned numerous activities in any urban centre, and would want to visit all places of choice during a leisure trip, and because of time constraint, a repeat visit to any park is often difficult during their stay.

Table 1. Number of Visitation to Parks per Week

Number of Visitation	Frequency	Percent (%)
Once	207	64.7
Twice	100	31.3
Three Times	10	3.1
Four Times	0	0
Five Times	0	0
Total	320	100

Source: Authors Field Work, 2017

The second analysis result is presented in table 2. According to the table, majority (82.8%) of urban tourists who visited the selected parks are satisfied and impressed with the condition of the playground as a significant number rated them to be in good condition. This connotes that the existing playgrounds are well maintained and spacious enough to accommodate visiting tourists conveniently. The condition of sport facilities in the parks from the view point of visiting urban tourists indicates high level of commendation as they are rated positively high by majority (83.1%) of them, implying that they are well maintained.

In terms of the condition of the available toilet facilities in the parks, 54.7% of tourists rated them positively and 46.3% rated them negatively low. While it will not be out of place to note that a significant number of sampled tourists appreciate the condition of the toilet facilities, results show that there are many tourists who are displeased with the condition of the toilets. Scenario of this nature is capable of discouraging tourists from visiting the selected parks in addition to reducing time spent in the parks for relaxation.

Table 2. Quality of Facilities in Selected Parks in Abuja

Facilities	Frequency	Percentage (%)
Playgrounds		
(i) Very Poor	5	1.6
(ii) Poor	4	1.3
(iii) Fair	46	14.4
(iv) Good	119	37.2
(v) Very Good	147	45.6
Sport Facilities		
(i) Very Poor	12	3.8
(ii) Poor	42	13.1
(iii) Fair	91	28.4
(iv) Good	118	36.9
(v) Very Good	57	17.8
Toilet Facilities		
(i) Very Poor	71	22.2
(ii) Poor	70	21.2
(iii) Fair	82	25.6
(iv) Good	80	25.6
(v) Very Good	17	5.3
Picnic/Barbecue Areas		
(i) Very Poor	7	2.2
(ii) Poor	6	1.9
(iii) Fair	48	15.0
(iv) Good	117	36.6
(v) Very Good	142	44.4

Flowerbeds		
(i) Very Poor	6	1.9
(ii) Poor	5	1.5
(iii) Fair	68	21.2
(iv) Good	108	33.8
(v) Very Good	133	41.6
Walkways		
(i) Very Poor	2	6
(ii) Poor	7	2.2
(iii) Fair	62	19.1
(iv) Good	108	33.8
(v) Very Good	141	44.1
Access Roads		
(i) Very Poor	1	3
(ii) Poor	4	1.3
(iii) Fair	53	16.6
(iv) Good	96	30
(v) Very Good	166	51.9

Source: Authors Field Work, 2017

Taking the picnic and barbecue areas of the parks into consideration, majority (81%) of the sampled tourists were delighted with their experience when they were in close contact with this attraction, which contributed to the positive high rating of the attraction. Additionally, the flower bed areas of the park were also rated positively high as over 70% of tourists appraised them commendably. This implies that the management of the selected parks are constantly engaging their gardeners to maintain the flower beds regularly, which is pertinent in keeping any park alluring.

As for the walkways that is also refer to as pathways, 77% of tourists opined that they are well laid out, clean and in good condition; making them appear convenient for easy walk around the parks to all places of attraction. Furthermore, an appraisal of the state of access roads to the parks shows that they are not in deplorable as majority (81.9%) of tourists are satisfied with their condition.

Effect of Facilities Quality on Visitors Patronage

Table 3 present the result of the relationship between facilities quality and frequency of tourists' patronage of urban parks in Abuja city. From the results, it is evident that only three out of the seven facilities examined significantly influence tourist's patronage. These facilities are toilets, flower bed, and access roads. This result emphasized the significance of good access roads and transportation service and agree with the position of Reigner, Kiser, Lawson, and Manning (2012), which established that providing vital and high-quality transportation services to visitors in parks is an important component of managing parks and recreation areas. Chi-

square results show that the condition of playground, sport areas, picnic/barbecue areas and walkways does not significantly influence patronage of parks in Abuja city, but the condition of toilets, flower beds, and access roads do. While the results show highly negative significant effect (17.116, -0.002**) of condition of toilets on tourists' patronage of the parks, the condition of flower beds and access roads significantly and positively (9.562, 0.05* and 9.313, 0.05*) influence tourists patronage of the parks.

Table 3. Chi-Square Analysis of the Relationship between Quality of Facilities and Tourists Patronage of Urban Parks in Abuja City

Facilities in Parks	Frequency of Visit (Chi-Square Test)	Sig. Level	Decision
Playgrounds	1.995	0.737	Not significant
Sport Areas	3.732	0.443	Not significant
Toilets	17.116	-0.002**	Highly significant
Picnic/Barbecue Areas	1.909	0.752	Not significant
Flower Beds	9.562	0.05*	Fairly significant
Walkways	8.529	0.74	Not significant
Access Roads	9.313	0.05*	Fairly significant

Note: P < 0.05*, P < 0.01**, P < 0.001***

Source: Authors Field Work, 2017

CONCLUSION AND RECOMMENDATIONS

The study set out to investigate the effect of condition of facilities in urban park on tourists' patronage since the quality of facilities is an essential and critical aspect of tourism development in any destination. This is because the condition of facilities somehow have a direct and indirect relationship with tourists' experience. From the foregoing findings and discussion, it is evident that the available facilities examined are well put to use and are currently enjoying some level of patronage. Facilities such as the sporting equipment's, playground areas, picnics and barbecue areas, and walkways are in good condition and appreciated by tourists, while the toilets facilities are not well maintained, which is worrisome as it has potential of making the experience of tourists unfulfilling and can also affect repeat visit intention. Thus, the study recommends that all facilities particularly the toilets in the parks in Abuja city should be properly and regularly maintained to enhance increased patronage.

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Passive Design Strategies for Sustainable Operation of NYSC Camp Buildings, Minna, Nigeria

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Abstract:

Niger State is characterized by tropical dry climate of minimal rainfall and dry hot periods, with an average temperature of 33ºC at its hottest months. The NYSC orientation course takes place four times in the year which cuts across the dry temperate periods of the year. This extreme dry, dusty and hot weather results in asthma, cough and other related sicknesses for building users. As a result, several corps members seek redeployment. Observation shows that NYSC camp buildings are designed with little or no consideration for passive comfort of the users. Lectures, trainings and other social activities are largely dependent on mechanical energy for cooling, which are insufficient and not cost effective. The aim of the paper is to investigate users comfort in the buildings, with the objective to promote low energy architecture, using passive design strategies. Quantitative methods were used to collect data on the users' perception of comfort within the buildings. Findings suggests insufficient natural ventilation, inappropriate building orientation, absence of shading devices as contributors to thermal discomfort of the users. The paper recommends passive design strategies among which are landscaping elements, to achieve users comfort and low energy consumption in the NYSC camp buildings. It concludes that there is a need for redirection in the design of NYSC camp, which puts into consideration the climatic condition of the environment where the camp is situated.

Keywords: *Comfort, Low Energy, Operation, Passive Design, Sustainable Building.*

INTRODUCTION

The evolution of building designs that generate self-indulgent solutions to habiting challenges has been a focus of research in the field of modern architecture. The users of a building may change over time, even whilst the building maintains its purpose. According to studies by Kaitilla, 1993, Ukoha and Beamish, 1997, Zeiler and abaoxem, 2008, Meir et al., (2009) standards and specifications have largely varied with the need of building users, thus causing an increase in the dissatisfaction of users with the building performance. User thermal comfort has been a crucial area of concern in most tropical regions to improve this building performance and ensure a desirable comfort condition in buildings. The study discusses how the thoughtful make-shift strategy of mechanical ventilation which is energy intensive can be drastically reduced. Furthermore, how energy use in buildings can be controlled, as it results in continuous release of carbon dioxide (CO2) into the air resulting to rising temperatures and climate change globally (Akande, 2015).

Passive design principles approach heat, lighting, mechanical power distribution and implementation using environmentally conscious strategies. Heat is efficiently collected and distributed using natural means, making thermal comfort become very crucial in a building, as it impacts productivity and improve user's health (Huizenga et al., 2006).

Danfulani and Aja (2008) discusses how the antecedents in Nigeria's history emanated the NYSC program by decree No. 24 of 22nd May 1973 to promote national unity among youths. Building facilities have been constructed to accommodate the activities. These building facilities are at optimum use during hours of intense solar radiation of the savannah region climate. The research focuses on the implementation of passive building design principles that aid user's thermal comfort for the design of the NYSC orientation camp in Paikoro, Niger State,

with the assessment of the passive design elements in the orientation camp. The design thus integrates approaches using forms of materials such as Masonry (concrete, bricks and stones) and water," attached greenhouse" which makes use of both direct and indirect gain of sunlight, building orientation, orientation of openings, building shape, use of water walls, use of thermal and trombe walls, shading devices in providing thermally satisfactory spaces. This suggests the need for more thermally comfortable spaces.

Case studies and research data shows the congestion as a result of increased number of occupants for spaces designated for lower number of occupants resulting in thermally dissatisfactory spaces. The NYSC orientation camp facility is facing the problems of thermal comfort, inadequate ventilation and excessive heat during hot climate, due to congestion of limited spaces, and lack of a proper and permanent camp facility purposely designed to cater for the category of users and participants of the camp programme. The use of active measures (mechanical equipment) to achieve users' comfort has currently become a matter of necessity, as a result of harsh weather conditions of the North Central region.. This active means of achieving thermal comfort have incurred the challenge of high cost of maintenance, unavailability due to insufficient funds and government support to provide them and thus should be brought to minimal requirement by the support of passive elements and design principles.

Passive Design Principles

Passive design principles have remained a traditional part of vernacular architecture for thousands of years in many countries before the integration of mechanical cooling and heating into buildings (Crosbie, 2008). The ancient Roman, Greek and Chinese were the ones who redefined and modified the major principles of passive design who positioned their buildings toward the south to offer a considerable amount of warmth and light (Butti *et. al.,* 1980). The primitive idea and lack knowledge of houses made them turned buildings to face the winter sun. Later on, the European technological improvements were abandoned after the fall Rome but persistent in China where astral traditions associate the south with summer, warmth and health (Xenophon, 1979).

Passive Design Features

Passive design features are architectural design or planning attributes or element used to enhance or achieve comfort and cooling within the building. They are features that used to achieve a desirable comfort condition and maintaining user's well-being without the use of active means (Brown, 2011). These features are highlighted under the following;

1. Building orientation
2. Building shape and massing
3. Vegetation
4. Openings (windows, court yard and atrium)
5. Solar shading
6. Building materials

Deductions

The study will only research into assessing the amount of comfort experienced by the previous and current camp users which includes both the Corp members, staffs and officials and auxiliary users of the camp facility, and also examine passive design measures that can improve subsequent users' thermal comfort in the proposed permanent NYSC camp facility. The passive design strategies or principles in this research build a focus how the design of the NYSC orientation camp buildings can be designed to achieve thermal comfort of the users, thing inherent energy from strategies employed. This is against the active strategies used to and thermal

comfort, which employs random number of external energy sources such as electricity, natural gas etc. the passive design strategies implement an energy efficient building, which is also a recertify for buildings which have a flexible number of occupants.

The aim of the study is to investigate the problems associated with thermal comfort of users (Corp members and officials) of the NYSC orientation Camp buildings with a view to propose design with the integration of passive design principles.

METHODOLOGY

The research makes use of a descriptive research effort to systematically describe the relevant information relative to the situation, problem and circumstances that surround the Camp Design. Using the qualitative and quantitative data for measuring thermal comfort and its extent in the NYSC Orientation Camp paikoro Niger State. Justifiable conclusions and recommendations are then drawn from the derived data. The case studies examined are existing NYSC Orientation Camps located around Nigeria.

Random selection method of subjects was done, and some of the NYSC CAMP case study locations include; Plateau State, Anambra, Kogi, Ogun, Lagos, Nasarrawa, Oyo, Bauchi etc. Variables used to measure thermal comfort were assessed using observation schedule. Photographs taken during physiographic observation were taken to show some of the variables observed in the field. Physical Instruments such as measuring tapes, scale rule was used on the field work to take measurements where necessary. Both the primary and secondary sources of data are used to derive the necessary information required to make analysis and conclusions.

Primary data used for the purpose of the research was obtained from fieldwork and descriptive survey carried out in randomly selected NYSC orientation camps including the existing NYSC Orientation camp used in the proposed site.

Observations were carried out to understand the passive design features used to achieve thermal comfort. Focus questions used to obtain the data are directed towards the passive thermal comfort. Interviews were carried out alongside Observation Schedule in the collation of data gathered during the field work.

Table 1: Overview of primary data on passive design

S/N	DATA	TYPE	SOURCES
1	Site Orientation	Qualitative	Observation
2	Building Shape	Qualitative	Observation
3	Massing	Qualitative	Observation
4	Landscape Consideration	Qualitative	Observation
5	Solar Shading Devices	Quantitative	Observation
6	Thermal Mass and Insulation	Qualitative	Observation
7	Openings (Windows, Courtyard and Atrium)	Qualitative/Quantitative	Observation

(Source: Author's Research Work, 2021)

Secondary data used for the purpose of the research was also gathered from existing NYSC journals and magazines, published NYSC literatures and articles. Relevant literatures are reviewed as a basis for a comprehensive theoretical background on which the research decisions were made.

Current information about passive design principles used in camp facilities obtained from internet such as; preferred window types, landscape alternatives etc. Data generated from the research provides the criteria and variables used for the observation, planning, organizing and designing of the proposed NYSC Orientation Camp with an intention of achieving thermal comfort.

Table 2: Data Obtained from Secondary Data Sources

S/N	DATA	TYPE	SOURCE
1.	Research Documentaries	Qualitative	Literature
2.	Population Estimate	Quantitative	Interview
3.	Maps	Quantitative	Internet
4.	Psychological effect of thermal comfort on occupants	Qualitative	Interview
5.	Site Location of NYSC camps	Qualitative	Interview
6.	Allocations, prototypes and past records of NYSC	Qualitative	Literature

(Source: Author's Research Work, 2021)

Data Collection

A close ended questionnaire and a structured observation schedule were used to obtain a data. Corp members and officials were randomly selected from existing NYSC camp locations, and questionnaires administered to them. The questionnaire was organized to obtain relevant data on passive design elements / considerations used to achieve security within the facilities. A structured observation schedule was also employed to determine passive design element/considerations used for security and the application of these elements/ considerations in mixed use buildings.

Population of the Study and Sample Frame

Thirteen States across Nigeria was selected as areas of study. The NYSC Orientation camps are located across the 36 states of Nigeria. The Niger State NYSC Orientation camp at Paikoro local government Niger State which has the proposed site was the first area of study. Major research work commenced there. The 13 NYSC Orientation camps were randomly selected in different states. The camp locations were visited and relevant data instruments were applied to access needed information.

A sample size of three NYSC Orientation camps was drawn for the research. Questionnaires were administered to corps members, camp officials, camp marketers and other camp users. Based on convenience sampling method employed by the researcher, The Niger state camp, Abuja Camp and the Nassarawa State Camp were the samples selected for the research. Also based on Judgmental sampling method, the three samples selected are characterized by the Dry sub-Saharan climate which ranges between 19 to 38 degree Celsius during the dry season. The high temperature these areas are characterized with makes the subject of thermal comfort a basis of observation in this area.

Observations and Interviews were carried out and shared at the sample locations. One of these sample locations include the Abuja camp. It is located in the Kubwa district of the FCT. Interview with camp officials reveals an average of 4000 Corp members which are posted to the camp in every stream. The Niger state Orientation camp which is the site location for the proposed new camp was also selected to take samples. The camp is located in Paikoro along the Minna/Abuja road. Interview reveals an average of 2000 to 2500 accommodated on the site. The Nasarrawa State NYSC camp located along the Abuja/Keffi expressway has an accommodation capacity of 3000 Corp members. The Nasarrawa camp also has its weather as the Sub-Saharan dry climate of the North Central. It also has its current location as its permanent site. Secondary data obtained by study of literature reveals that Magaji Dan Yamusa. Nasarawa is a newly constructed site.

Variables of the Study

This shows a record of Interview guide, physical observation records and an analysis of each of the orientation camps studied. The Interview guide is subdivided into sections.

1. The first section contains participant's information.

2. Relevant data for the camp is filled in this section. Perceptions and personal opinions about comfort as a result of thermal condition of the NYSC camps. These entails a total of 12 questions which were administered across corp members, camp officials and users of the camp facilities.
3. A structured observation schedule was also used for the assessment of passive principles that aid thermal comfort in the Orientation Camp facilities. The following are some of the variables used in this assessment.

DISCUSSION OF RESULT AND DATA ANALYSIS

The primary source for obtaining data for the research work include the use of questionnaires and observations, especially in the examination of thermal comfort in the NYSC Camps. Statistical analysis is used to analyze the data obtained from the field work to get quantitative result. Microsoft Excel spreadsheet was used for analysis in this study.
The data obtained from field work is analyzed and discussed in this section. Google forms and Microsoft Excel Spreadsheet are used to get a descriptive statistic of data obtained from field survey of some NYSC camps. The results obtained were evaluated based on the research objectives.
The research objective which is to determine the perception of comfort of the current NYSC orientation camp facilities users was carried out by the researcher through administering questionnaire. A well-structured questionnaire was administered to camp facility users using Google forms. A hundred and one (101) form was submitted online and was analyzed. Data collected shows 52.5% of the respondent are female while 47.5% are male.

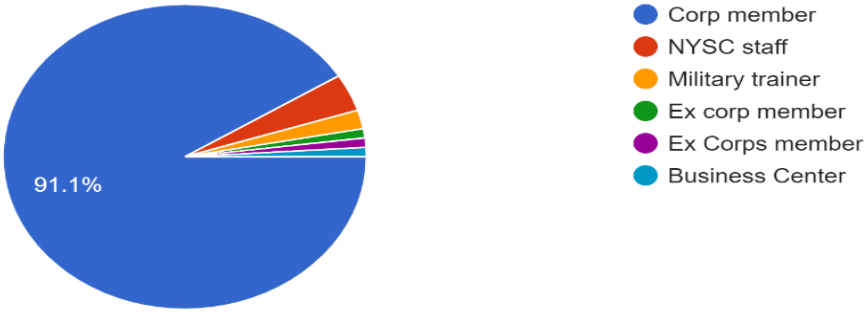

Figure 1: Categories of User in NYSC camp facilities

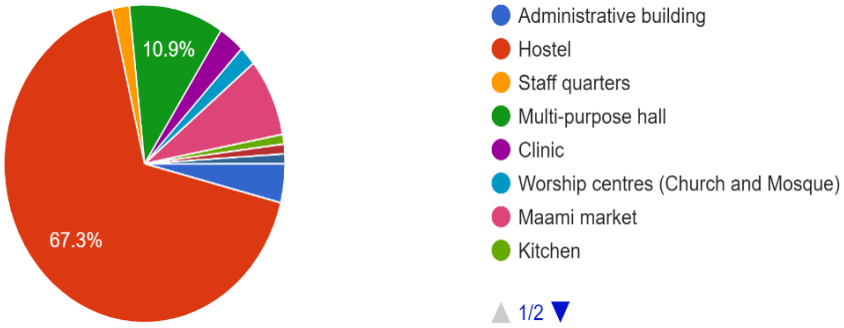

Figure 2: Buildings often used in the orientation camp

Figure 3: Users Experience on indoor environmental quality within the orientation camp

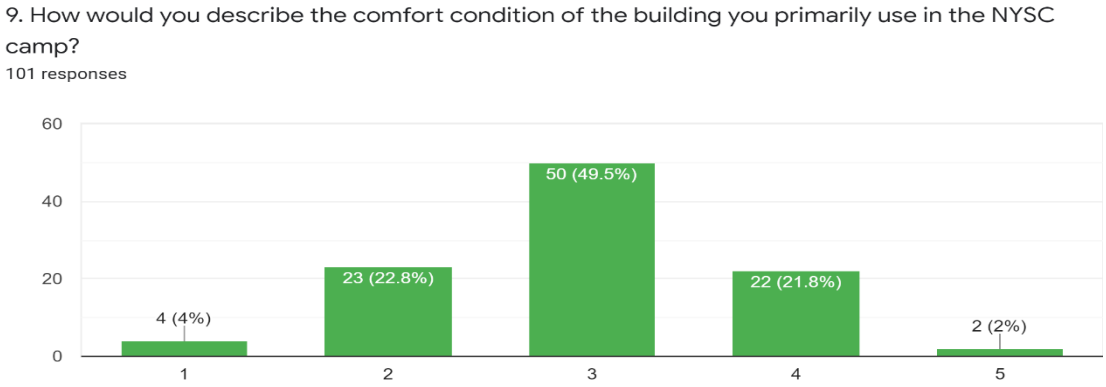

Figure 4: Comfort Condition of camp facilities

CONCLUSIONS AND RECOMENDATIONS

This research exposes the degree to which existing NYSC camps have some passive thermal comfort design elements which were integrated in them. It was therefore researched how most of the principles adopted were not very effective as some of these measures were not primarily for cooling purposes only. It is therefore worthy of note that the proposed NYSC camp facility incorporates effectively the design features to reduce dependency on active or mechanical means of cooling and ventilation. One of the major benefits of this research is the reduction in the emphasis of the need for high energy demands or mechanical provisions for achieving thermal comfort. Thermal comfort within the NYSC Camps makes the users of the space psychologically satisfied and productive. Hence, the need for passive design features for thermal comfort on buildings to carve a pleasing and comfortable living, learning and training environment for the Corp members. In order to provide a thermally comfortable training environment and precinct where user's needs are met, and are maximally satisfied with the indoor conditions, the following are recommended:

i. Number of corp members allocated to the NYSC Orientation Camp locations should be restricted to the facilities and space provided as in the design.

ii. Passive design principles for thermal comfort should be integrated effectively on all buildings mainly with the aim of providing comfort and improving indoor air quality and not for aesthetic purposes.
iii. The Provision of courtyards with open roof design allows natural ventilation and crossed ventilation.

Table 3: Passive design principles adopted in orientation camp facilities

S/N	NYSC Orientation Camps	Building Orientation and Shape	Use of Building proper materials	Provision of sufficient openings of windows	Presence of spacious lobbies, Courtyards	Form of Landscapes features and Vegetations	Form of Solar Shading device
1	Niger Paikoro	No	Cement Blockwalls, Aluminium roofing sheet	Louvres	N/A	N/A	N/A
2	Kubwa Abuja	Rectangular Bungalows	Sandcrete walls, Aluminium roofing sheet	Sliding Glass windows	Courtyards	Scanty Vegetation	
3	Magaji Dan Yamusa	Rectangular Building Shape	Cement blockwalls, Aluminium roofing sheets	Sliding windows	Presence of Lobbies	Shrubs and Shading trees, good landscape	Roof Eaves, Absence of fins
4	Ede, Osun State	Rectangular Bungalow buildings	Block walls, Aluminium roofing sheets, ceramic floor tiles.	Slidng glass windows	Verandas, lobbies	Shrubs, Hedges, Scanty Trees	Horizontal fins
5	Black Gold Kaduna	Rectangular Bungalow Buildings	Blockwalls,Terrazo floorings,	, Sufficient Openings, louvre windows	Presence of lobbies	Scanty vegetation and landscape features	Presence of deep verandahs, Roof eaves and Horizontal fins
6	Kabba Bunu Camp, Kogi State	Rectangular Bungalow Buildings	Stone walls, Blockwalls. Aluminium roofing sheets, ceramic tiles, Terrazo floor cover	Double Swing Glass window for ventilation	Insufficient Lobbies	Shrubs, Trees	Horizontal fins
7	Sagamu Camp, Ogun State	Rectangular Planned Bungalow buildings	Sandcrete Blockwalls, Ceramic Floor Tiles, PVC ceilings	Sliding Glass and Swing windows	Spacious Lobbies, Courtyards	Insufficient Trees and Vegetations	Eaves, Absence of fins
8	Ipaja Agege, Lagos	Multi-Storey Building	Concrete pavements, Sandcrete blockwalls, Aluminium roofing sheets,	Louvres	Lobbies,	Absence of Vegetations	Horizontal fins
8	Akwa Ibom	Rectangular Bungalow Buildings	Aluminium Roofing Sheets, Blockwalls, Terrazo floor cover	Louvre window types	N/A		
9	Plateau	Bungalow Buildings	Sandcrete Blockwalls, Aluminium Roofing Sheets	Sliding mirror glass windows	Presence of Courtyards and Atriums	Interlocking tiles for hard landscape,	Roof Eaves, Absence of external wall fins in hostel buildings

iv. Proper landscaping of the indoor and outdoor environment with aesthetically pleasing plants and trees to improves indoor air quality and conditions.
v. The choice of building materials should be done with consideration for thermally insulated properties.
vi. Proper building Orientation improves lightning results, ventilation of spaces and effect of sunlight.
vii. The research recommends the use deep verandas or balcony to serve as shading element to reduce direct solar radiation impact on the building.

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Integration of People's Perception of Landscape in the Design of Recreational Parks, Minna, Nigeria

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Abstract:

Recreation encompasses multidimensional activities that contain the exercises of physical, cognitive, emotional and social interaction. Studies have shown that people in Minna face many problems in outdoor recreational areas, including recreational parks. Thus, the aim of this study is to investigate people's perception of landscape in the design of a recreation park in Minna, Niger State, Nigeria. The research method adopted by this study is quantitative in nature in which data obtained from the distributed of questionnaires were analysed. The parameters measured in this study included six perceptual categories (vegetation, open smooth, open coarse, rivers, agrarian, and structures) and the allocentric and autocentric perception modes. The sampling method adopted by this study is the Laddering technique where by data was collected in an unstructured manner based on a Means-end theory. Thus, the probability sampling technique was adopted as the sample technique for this study. It was discovered that the most desired landscape settings were structures, open smooth landscapes and water bodies and a statistical relationship exists between gender and the perception of these settings. Thus, it is recommended that recreational park designs should take into account not only the spacial qualities of landscape settings but also perceptual qualities so as to optimize the experience of people visiting recreational parks.

Keywords: Recreation, Landscape, Perception, Recreational Park

BACKGROUND

A vital component of any residential neighbourhood or community is the space that is dedicated and devoted to satisfying active and passive recreational needs (Olaleye, 2014). As such, recreation comprises multifaceted activities that involve the exercises of physical, cognitive, emotional and social interaction (Broadhurst, 2001).

Typically, society suggests that recreation takes place during "leisure time", it is therefore closely associated with the concept of leisure (Hailegiorgis, 2017). Recreational parks are places of great ecological, social and environmental importance. Thus, according to Recreational Park Landscape (2019), the existence of recreational spaces and gardens in various communities help to meet very necessary social and recreational needs. Hailegiorgis (2017) further explained that for a society as a whole, leisure provides an ideal medium for the transmission of historical, social and cultural values that promote desired norms, social orientations, and customs.

The benefits of recreational parks in communities extends towards accounting for the well-being of people. In an investigation carried out on the effect of recreational park visits on park goers, a significant correlation was discovered between the use of the parks and the observed state of health of people, hence people who used local parks frequently were more likely to report good health than those who do not (Godbey *et al.*, 1992). Therefore, recreational parks are known to be of numerous benefits to both individuals and communities.

In a study done by AbdRazack *et al.* (2013), to assess the behaviour and preferences of Minna city dwellers to outdoor recreation, it was revealed that majority of the respondents (92.4%) indicated that they faced many different problems in outdoor recreational areas. It was thereby recommended to understand the problems in existing outdoor recreational areas in Minna, from people's point of view.

Thus, the aim of this study is to investigate people's perception of landscape in the design of a recreation park, in Minna, Niger State, Nigeria.
According to Public Participation (2008), the American Society of Landscape Architects advocate that an open, participatory design process can create better communities and a healthier environment. Thus, public involvement will help identify the issues important to the community and develop the most appropriate planning, design, and management solutions.
The scope of this research covers the area of Minna, located in Niger state, for recreational parks to be specific.

This research seeks to contribute to the body of knowledge in research by exploring and highlighting the various ways in which the views of people can be applied in the design of recreational parks in Minna, Niger state, Nigeria.

The Concept of Perception

Perception is described as the way of recognizing and interpreting information gathered by the human senses (Essays, 2017). Perception is at the core of environmental behaviour because it is the store house of the interaction that occurs between humans and the external environment (Proshansky et al., 1970). In a study conducted on Situated Cognition and the Phenomenology of Place, Seamon (2015) explained that in a typical lifeworld, the qualities of materiality, spatiality, and place directly resonate with humans and, though usually done subconsciously, prompts immediate actions and meanings. Therefore, perception is derived from the subconscious value given by people about the qualities of materiality, spatiality and place. Hence, Schachtel (1959) postulated that there are two basic modes of perception; the autocentric and allocentric perception modes.

Autocentric Perception Mode

Autocentric perception is describes by Porteous (1996) to be subject centred involving sensory quality and pleasure. Schachtel (1959) further explained that autocentric perception is described by how the subject or perceiver feels as such, objectification is fairly employed in the autocentric perception mode. Thus, the perceiver momentarily reacts to the object and considers it pleasurable or not pleasurable rather than being in engagement with the object. This phenomenon is similar to the concept of internalism. Internalism, as highlighted by Démuth (2016) suggests an explanation for the existence of intuitive and innate cognition. Thus, internalist propose that within an individual lies the source of knowledge and not from the external environment (Démuth, 2016). Autocentric perception is thereby characterized to be of lower senses such as taste, smell, touch, pain and proprioception. Vision, excluding the perception of colour is associated with autocentric perception (Porteous, 1996).

Allocentric Perception Mode

Allocentric perception on the other hand is object centred involving attention and directionality (Porteous, 1996). Here also, an approach likened to allocentric perception is considered. The externalism approach gives account to the derivation of knowledge and perception. In this approach, externalists assert that the mind (tabula rasa) can be compared to a blank sheet of paper in which concepts are imprinted on (Démuth, 2013). Thus, all knowledge is imprinted on the mind from an external reality. Schachtel (1959) explained that allocentric perception is characterized by higher senses like sight and hearing. All types of sound, except speech sound is considered allocentric (Porteous, 1996).

In a different light, Schachtel, (1959) discussed that for allocentric senses, higher senses such as sight and sound are capable of autocentricity but to a limited extent, and autocentric senses (lower senses) are capable of, but also to limited degree, allocentricity.

Necka (2011) further concluded that nature is more prone to be perceived in the light of allocentric perception mode than in the autocentric perception mode.

Human Perception of Landscape

In past times, researchers have sought to investigate landscape perception based on different cultural backgrounds. In a study done by Herzog et al., (2000), to investigate the perception of Australian natural landscapes by American and Australian respondents, findings showed that preference correlations were on the high side. Generally, this yielded the six perceptual categories; vegetation, open smooth, open coarse, rivers, agrarian, and structures. Priego, Breuste and Rojas (2008) also conducted a study on the perception use and behaviour of people from Chile, Germany and Spain in various urban landscapes, it was concluded that people perceive urban landscape differently. Matijosaitiene (2011) explained that, among others, the differences in landscape perception can be revealed in different social groups like age, ethnicity, place of residence (urban or rural), gender, education (high or elementary school) and occupation.

Perception of any given environment helps one to understand and react to their environment.

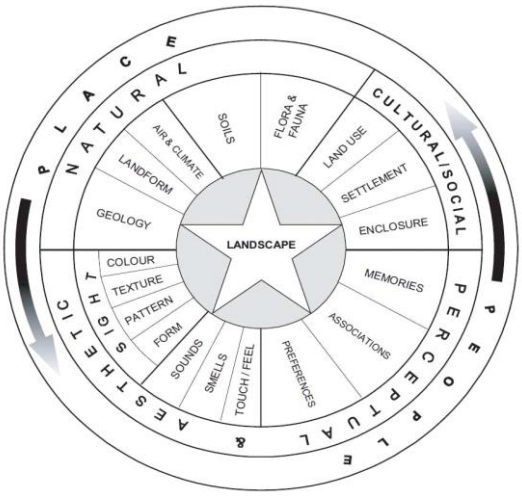

Figure 1: Factors and Components Influencing Landscape Character
Source: (Swanwick, 2002).

As highlighted by Zube et al. (1982), the perception of landscape is as a result of the interaction between humans and landscape features. Swanwick (2002) further explained that the character of landscape is derived from the manner in which various components of our environment - both natural and cultural land use relate with one another and are perceived by people. Thus, the figure below shows a pictorial representation of the factors and components that determine the landscape character of a place.

As highlighted by Swanwick (2002), landscape is derived from the manner in which various components of our environment - both natural and cultural land use relate with one another and are perceived by people. Hence, the components highlighted in figure 1influence the landscape character of a place and consequently, what is experienced and perceived by people.

Managing Recreation Experience

Borrie et al., (1998) explained that in practice, managing recreation experience is difficult because experiences are constructed in a complex interaction between people and their internal state together with the activities they are involved in and the environment in which they find themselves. Since recreation experience is acknowledged to be complex, recreation research and management have a goal-directed approach in which recreational activities and settings are

considered substitutable (Pietila and Kangas, 2015). Thus, recreational activities depend on the landscape settings. According to McCool (2006), landscape settings are places that contain natural or cultural heritage desired by visitors that are subject to biophysical impact like erosion which can be managed for visitors' experience. Therefore, to optimize recreational park visits, there is the need to examine the relationship between landscape settings and people's experience.

Methodological Approach to Examine the Relationship between Setting and Experience

Various methodological approaches have been employed to examine the relationship between setting and experience. These approaches are the direct and indirect approaches. The direct approach allows respondents to answer about their perception of multiple factors that are assumed to affect experience, while with indirect approach, secondary measurements form the basis for statistical analyses that examines the setting-experience relationship (Pietila and Kangas, 2015). Pietila and Kangas (2015) explained that direct approaches can be expressed in various kinds, such as the Satisfaction approach, Normative approach, Experience sampling method (ESM) and Laddering Technique.

The Satisfaction approach relies on evaluating the overall satisfaction of visitors by evaluating how recreational park goers, often regarded here as visitors, are satisfied with multiple setting factors. According to Newsome et al., (2012), the most regular direct approach in recreation research has been the satisfaction approach. For the Normative approach, respondents evaluate the extent, considering various hypothetical setting attributes, to which these settings add or detract having an optimized recreational experience (Cole and Hall, 2009). Experience based approach focuses on the nature of the experience itself. Experience Sampling Method (ESM), has been used to encapsulate the multiphasic nature of the experience by asking respondents to describe their experiences (Cole and Williams, 2012).

Last to be considered from the direct approach is the Laddering technique. This technique is based on a Means-end theory. It provides the framework for creating a means-end chain that describes the relationship between setting attributes and their reaction from the recreationist or visitors. It is implemented using a semi-structured interview to identify the elements of the means-end chain (Gutman, 1982). The process usually begins by bringing out the key attributes for decision making followed by asking why a particular attribute is important also why the perceived consequence of the attributes is important, aiming to discover the personal values and views of the respondents (Pietila and Kangas, 2015).

However, Pietila and Kangas (2015) highlighted that the indirect approach involves the use of statistical analysis to determine the relationship between recreational experience and settings. For the indirect approach, recreational experiences are first operationalized and measured using a Recreation Experience Preference (REP) scale to determine the various recreation experience domains such as physical rest or privacy (Driver, 1983). With the REP score, the Recreation Opportunity Spectrum (ROS) which is regarded as the respondents' preferences, is then used to represent the settings influenced by recreational activities. Thus ROS-based studies supposedly divide the recreational landscape into heterogeneous zones of recreation opportunities and test for REP scores across the zones (Pietila and Kangas, 2015).

All the approaches mentioned above have short-comings while capturing the relationship between setting and experience (Pietila and Kangas, 2015). The direct approaches are flawed because of the lack of the inclusion of spatial dimensions, as tourist's destinations like national parks are internally a heterogeneous 'space-time mosaics' (Saarinen, 2004). Pietila and Kangas, (2015) asserted that although the indirect approach consider spatial aspects, conclusions have

not been yielded, thus researchers are employed to explore approaches that account for the spatial and social components of the setting-experience relationship.

In recent times, the linking of social dimensions to the concept of space is becoming prominent and with conceptual thoughts from study done by Manzo (2008), spaces known to be regarded as geographical areas as having just physical attributes have evolved to the term 'place'. Place is thus known to include people's meanings, values and experiences. The concept of place functions as a link between social experiences and geographical areas and aids in understanding the diversity of the meaning people attach to land and resources they manage (Galliano and Loeffler, 1999). Therefore, in assessing people's experience, one must consider the concept of place as a function of both a geographical location and people's perception of the space. This can be done adopting the laddering approach, aiming to investigate people's perception of landscape, postulates that respondents share opinions about landscape attributes and settings in an unstructured manner.

METHODOLOGY

The research method adopted by this study is the mixed research method which comprises of both the quantitative and qualitative research methods. The sampling method used to investigate landscape perception is the Laddering technique. The Laddering technique, as described by Gutman, (1982), is implemented by employing unstructured questionnaires to gain insights about perceptions of landscape attributes and settings. Thus, the sampling technique adopted by this study is the probability sampling technique whereby the sample was selected at random from the study area, Minna.

The parameters analysed in this study were obtained earlier from a study done by Herzog et al. (2000). Thus, the parameter obtained were cross-tabulated with the social-group factors highlighted by Matijosaitiene (2011). Other parameters measured were the perception modes postulated by Schachtel (1959). The variable analysed were obtained from the landscape perceptual qualities asserted by Swanwick (2002), these include form, texture, pattern, colour smell and sound. Thus, the cross-tabulation analysis and the Pearson's chi-square test were used to examine the relationship between the preferences for landscape settings, landscape perceptual qualities and social group factors. Hence, a survey was conducted to obtain the primary data analysed. The research instrument employed was the questionnaire, where by 352 responses were received from the 500 questionnaires distributed to residents of Minna.

Data collected were therefore analysed using the SPSS statistical analytic tool. Hence, the results from the analyses were obtained and represented in charts and tables.

RESULTS AND FINDINGS

The preferences for landscape settings were first analysed to determine the most desired in recreational parks. Below shows that from the landscape settings highlighted by Herzog et al. (2000), the preference for structures, open smooth landscape and waterbodies had the highest percentages.

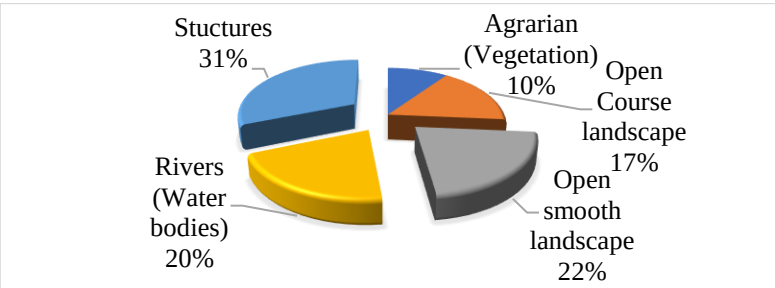

Figure 2: Preferences for Landscape Settings

The three preferences for landscape settings with the highest percentages were thus accentuated and analysed with the socio-cultural factors gender, age and ethnicity to understand the relationship between these variables. Therefore, to examine the relationship between age and the preferences for landscape settings, the preferences for landscape settings were cross-tabulated with age distributions for both genders. Below shows the result of the analysis.

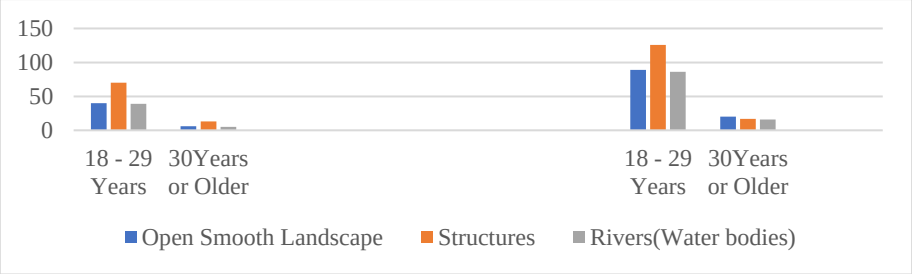

Figure 3: Cross-Tabulation between Age Distribution and Preferences for Landscape Settings for both Genders

Figure 3 shows the result of the cross tabulation between age distributions and the preferences for landscape settings for both genders. To compare the data for both genders, the results gotten are placed side by side, on the right is result gotten for male gender while on the left is for the female gender. A similarity was observed between the age distribution of 18 -29 years for both genders regarding the preferences for the landscape settings. On the other hand, the male gender of the age distribution; 30 or older is observed to have a higher preference for open smooth landscape than structures or water bodies. This could suggest the need for the male gender beyond the ages of 30 who have spent time in the urban world, to seek tranquillity from open smooth landscapes. According to World Bank (2015), men are more likely to be active in formal occupations in the urban world than women. This supports the claim that the male gender beyond the age of 30 are more likely to spend most times in man-made structures. This would imply the need and preference for natural open smooth landscapes as an escape from the urban environment. To further investigate the relationship between landscape preferences and gender across the age distributions, the Pearson's chi-square test was conducted. Statistic Solutions (2020), asserted that Chi Square tests are usually employed when testing the relationship between various categorical variables. Thus, according to Statistic Solutions (2020), the Chi Square statistic is expressed numerically:

$$x^2 = \sum((O - E)^2/E)$$

- Where, x^2 represents the *p*-value of the chi square statistics.
- O represents the observed frequency (the number of counts).
- E represents the Expected frequency if no relationship existed between the variables.

The *p*-value shows the relationship between variables, thus if results in any number less than 0.05, it can be concluded that the variables analysed are dependent (Statistic Solutions, 2020).

Table 1: Statistical Relationship between Preference for Landscape Settings and Gender as Regards Age Distribution

	P-value for Open Smooth Landscape	*P*-value for structures	*P*-value for water bodies
10-17 Years	0.576	0.361	0.171
18-29 years	0.27	0.437	0.517
30 or older	0.508	0.002	0.774

From Table 1, it was observed that the age distribution of 30 years or older shows a statistical relationship between the preference for structures and gender as the *p*-value yielded a figure 0.002 which is less than 0.05. Thus, this sheds light to the finding made in figure 3 where a

strong contrast is seen in the preference for structures in recreational parks, between the male and female gender. No statistical relationship was seen between gender and the preference for open smooth landscape and water bodies for ages 30 or older.

The perceptual qualities highlighted in figure 1 by Swanwick (2002) were cross tabulated with the social group factors; Ethnicity and gender. Thus, the landscape preferences were cross-tabulated with the indigenous ethnicities in Minna, highlighted by Muhammad (2012) to include the Nupe, Hausa and Gbagyi tribes. The Igbo, Yoruba and Idoma tribe were also selected for analysis due to the high number of responses obtained. Below showing the result of the analysis.

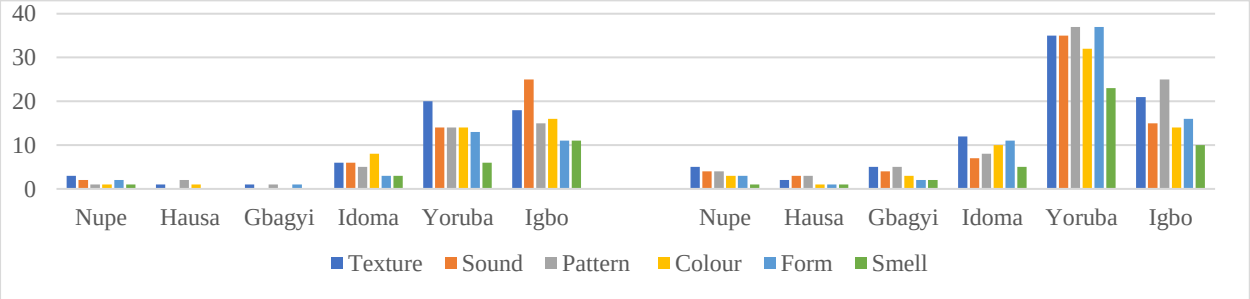

Figure 4: Cross-Tabulation between Ethnicities and Landscape Perceptual Qualities for both Genders

Figure 4 expresses the relationship between landscape perceptual qualities and selected ethnicities. On the left is the result for the female gender while on the right, for the male gender. To determine the perception mode adopted by each tribe, the first three perceptual qualities with the highest frequencies were selected and categorized according to the perception mode each quality belonged to. According to Van den Berg (2016), frequencies are used to summarize variables that are categorical in nature. Therefore, frequencies were used to determine the predominant perception mode adopted. For the female gender of the Nupe tribe, texture, form and sound had the highest frequencies, and hence the human senses responsible are touch, vision and hearing. Thus, the predominant perception mode adopted by the female gender of the Nupe tribe was discovered to be the autocentric perception mode. This examination was done for all the ethnicities considered and below shows the predominant perception mode adopted by each ethnicity.

Table 2: Predominant Perception Mode Adopted by Ethnicities

Ethnicity	Perception Mode Adopted by the Male Gender	Perception Mode Adopted by the Female Gender
Nupe	Autocentricity	Autocentricity
Gbagyi	Autocentricity	Autocentricity
Hausa	Autocentricity	Autocentricity
Yoruba	Allocentricity and Autocentricity	Autocentricity
Idoma	Autocentricity	Allocentricity
Igbo	Autocentricity	Allocentricity

Another cross-tabulation analysis was carried out between age distributions and the landscape perceptual qualities for both genders and the chart below shows the relationship between landscape perceptual qualities and the various age distributions. On the left is the result for the female gender, while on the right is the result for the male gender.

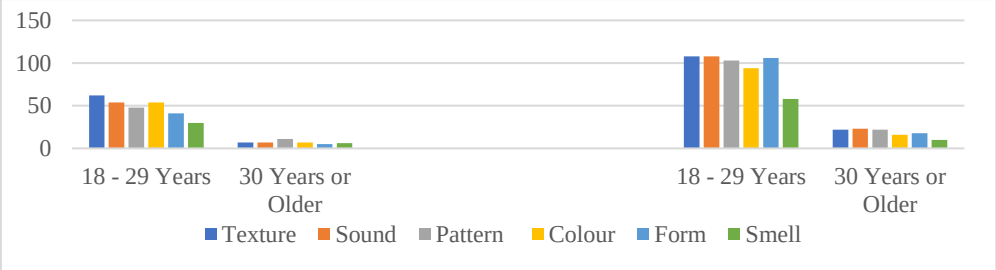

Figure 5: Cross-Tabulation between Ethnicities and Landscape Perceptual Qualities for both Genders

From figure 5, using frequencies to determine the predominant perception mode, it was discovered that of ages between 18-29 years, the female gender perceives landscape settings in an allocentric manner while the male gender perceives landscape settings in an autocentric manner. On the other hand, for the age distribution of 30 or older, it was discovered that the female gender adopts both autocentric and allocentric perception modes while the male gender of the same age distribution adopts the autocentric perception mode.

Findings

From the analyses above, numerous findings and insights were revealed about view of landscape-settings and also the landscape perceptual qualities for recreational parks design. Having put into considerations the special qualities of the landscape settings relating with perceptual qualities, it was discovered that the basic perception modes were predominantly adopted by various social group factors like ethnicity and age distribution. Thus, it was realized that for both genders, all three indigenous tribes in Minna; the Nupe, Hausa and Gbagyi tribes adopt the autocentric perception mode for landscape settings. The Igbo and Idoma tribe both adopt the allocentric perception mode while the Yoruba tribe perceive landscape setting through autocentricity and allocentricity. It was discovered that socio-cultural factor like gender have an influence on the perception of landscape settings.

CONCLUSIONS

Due to the psychological satisfaction natural landscape features give users, recreational park designs should be optimized taking into account the physical and perceptual attributes of landscape settings. The merging of the spacial qualities of landscape settings with perceptual qualities should be of paramount importance to recreational park managers, as it gives insights into the various ways recreational experience can be improved. Thus, for recreational park designs and managements in Minna, it should be ensured that landscape settings like structures, open smooth landscape and rivers are incorporated to suit the needs of residents. It is recommended that the landscape perceptual qualities like texture, pattern, colour, sound and form should be emphasised in landscape settings so as to optimize people's recreational experience in recreational parks in Minna, Niger State.

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Impacts of Urban Poultry Farm Activities on Water Quality in Kuje Suburbia, Abuja

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Abstract

The rapid rate of urbanisation is associated with unemployment and urban food security challenges. To address the food security challenges in cities, urban residents have embraced the practice of urban agriculture, a practice which involves the production of animals and crops in urban and peril-urban areas. Poultry farming is a vital approach toward providing urban residents with the required protein intake in form of eggs and meat. This study examines the impacts of urban poultry farms activities on water quality in Kuje suburbia. The parameters measured for water sample was carried out in a laboratory test to assess the physicochemical parameters of the water. The results show high concentration of TA, Mn, Ph, NO, and BOD above the WHO/ NESREA recommended standard in surface water, borehole, and well water sampled. In conclusion, the poultry farms activities impact the environment of the vicinity they operate by causing water pollution. The study recommends among others the need for appropriate distance between poultry farms and residences to be determined and enforced by regulatory authority. This will help to mitigate the effects of environmental pollution /health hazards on the residents.

Keywords: *Urban agriculture, Community health, Residents Perception, Environmental Pollution*

1.0 INTRODUCTION

The rapid rate of urbanisation is associated with unemployment and urban food security challenges. To address the food security challenges in cities, urban residents have embraced the practice of urban agriculture – a practice which involves the production of animals and crops in urban and peri-urban areas (Tornaghi, 2014).

Poultry farming is one of the major urban agricultural practices in Nigeria. It is a vital approach toward providing urban residents with the required protein intake in form of eggs and meat. FAO (2006), observed that the poultry industry globally has made tremendous changes to meet the increasing demand for inexpensive and safe supply of meat and egg. This increasing demand has been accompanied by structural changes within the sector characterised by the emergence and growth in commercial and industrial farming establishments as well as the intensification of poultry operations (Shashank, 2013; FAO, 2006). Poultry farming is capable of addressing the four core dimensions of food security, vis-a-vis food availability, food access, food utilisation and food stability (Sassi, 2018). However, poultry farming has been associated with a plethora of health and environmental impacts (Foeken, 2006).

The effects of poultry farms have been studied from various perspectives. Delgado et al., (2016) in their research indicated that the growth in meat consumption worldwide, has led to an increase of waste by livestock systems that pose dangers to the environment. Kalhor et al. (2016), specifically focused their studies on airborne pollutants, poultry production releases significant emissions of ammonia (NH3), methane, and sulfur dioxide. Li *et al*., (2018) posited that between 30 and 90% of the antibiotics administered to livestock are excreted non-metabolized into the environment through manure. Xie *et al*., (2018a), also confirmed that contamination of antibiotics in the environment by anthropogenic activities increases the competitive advantage of antibiotic resistant bacteria by gradually reshaping the resistant in the environment. Livestock farming systems are major source of trace gases contributing to atmospheric pollution locally and globally (Appuhamy *et al*., 2016). The greenhouse gas emissions of livestock production and its by products accounted for 18% of global total emissions (IPCC, 2014). Other studies focused on the rate of waste generation and nutrient

contents of poultry waste production which are affected by a number of factors (Adedayo, 2012; Adeoye *et al.,* 2014).

A large number of studies have been conducted investigating various aspects of the environmental pollution and human health impacts of poultry farms, but no review has attempted to systematically explore the major pollutants emitted from poultry farms, their environmental impacts, and the potential human health risks from exposures to them. This study therefore aims at assessing the impact of poultry farms on water quality in Kuje suburbia. The important major impacts of poultry farms will be identified on the environment and human health. This paper therefore, prove indispensable to urban policy makers, planners, health and environmental organizations on environmental impacts of poultry farms.

2.0 LITERATURE REVIEW

Urban Sustainability: Environmental and Health Implications of Poultry Farming

Cities are considered as complex adaptive socio-biophysical systems (Childers et al., 2014). James et al., (2015) noted that cities are currently the habitat and 'zone of survival' of humanity in the 21st century. They identified the need to shift emphasis from the growth-based narrative to a more holistic consideration of cities as ecological systems whose alterations are capable of threatening human existence. Childers et al. (2014) observed that the urban sustainability is a result-based and solution-oriented theory that considers humans as 'ecological stewards'. In other word, urban sustainability is concerned with the development and consumption of healthy and liveable cities (Steiner 2011, 2014; Wolch *et al*. 2014). As James et al. (2015) argued, "Cities are at the heart of the problems facing this planet, but developing a positive and sustainable mode of urban living is the only way that we will be able to sustain social life as we know it past the end of this century". Rapid development of urban agriculture is associated with greenhouse gases (GHGs) and ammonia (NH3) emissions and climate change contributing to atmospheric pollution locally and globally (Piha et al., 2007; Broto and Bulkeley, 2013). Livestock farming systems are major source of trace gases contributing to atmospheric pollution locally and globally (IPCC ,2014; Appuhamy et al., 2016; van der Weele et al., 2019). The greenhouse gas emissions of livestock production and its by-products accounted for 18% of global total emissions, suspended solids, nutrients, metals and pharmaceutical compounds (Pimentel et al., 2005; Rodić et al., 2011; Sabiha et al., 2016). Application of Livestock manure has the consequence of nutrients and antibiotics which seep from soils into ground and surface waters, having a devastating effect on water quality, favouring the growth of algae, accelerating eutrophication and promoting the spread of antibiotic resistant bacteria (Hooda *et al*., 2000; Martinez, 2009; Girard *et al.,* 2014; Sabiha et al., 2016; Almeida *et al.,* 2017). Alabi et al., (2014), in their research found out that chicken droppings generally contaminate the litter spread in poultry houses and poses great environmental threats during the process of disposing the litter. This is because improper disposal leads to air pollution from unpleasant odours, breeding of flies, and water pollution. The effects of poultry farms have been studied from various perspectives. Delgado et al., (2016) in their research indicated that the growth in meat consumption worldwide, has led to an increase of waste by livestock systems that pose dangers to the environment. Kalhor et al. (2016), specifically focused their studies on airborne pollutants, poultry production releases significant emissions of ammonia (NH3), methane, and sulfur dioxide. Li *et al*., (2018) posited that between 30 and 90% of the antibiotics administered to livestocks are excreted non-metabolized into the environment through manure. Xie *et al*., (2018a), also confirmed that contamination of antibiotics in the environment by anthropogenic activities increases the

competitive advantage of antibiotic resistant bacteria by gradually reshaping the resistant in the environment. In view of the above-mentioned studies, emphasis is primarily on waste generation, environmental pollution from poultry production on human health. There is little research on issues related to the assessment of major pollutants released from poultry farms and the impacts on water quality on residents of the host farms. Therefore, this study attempt to examine the impact of urban poultry farm activities on water quality in Kuje Suburbia, Abuja.

3.0 METHODOLOGY

The study Area

The study was conducted within the geographical boundary of Kuje Area Council. Chukuku Kiyi and Chibiri of Kuje suburban forms the basis of analysis for the study. The Kuje Area Council covers a total land of about 1,800 square kilometres about 22.5% of the FCT (Ojigi *et.al*, 2012). It has an estimated population of about 270,000 people comprising Gbagyi, Gude, Bassa and Fulani with other ethnic group that have migrated from other parts of Nigeria and the world at large (Ojigi *et.al*, 2012). Kuje Area Council is bounded on the West of Gwagwalada Area Council, North and East of Abuja Municipal Area Council and the South of Abaji Area Council.

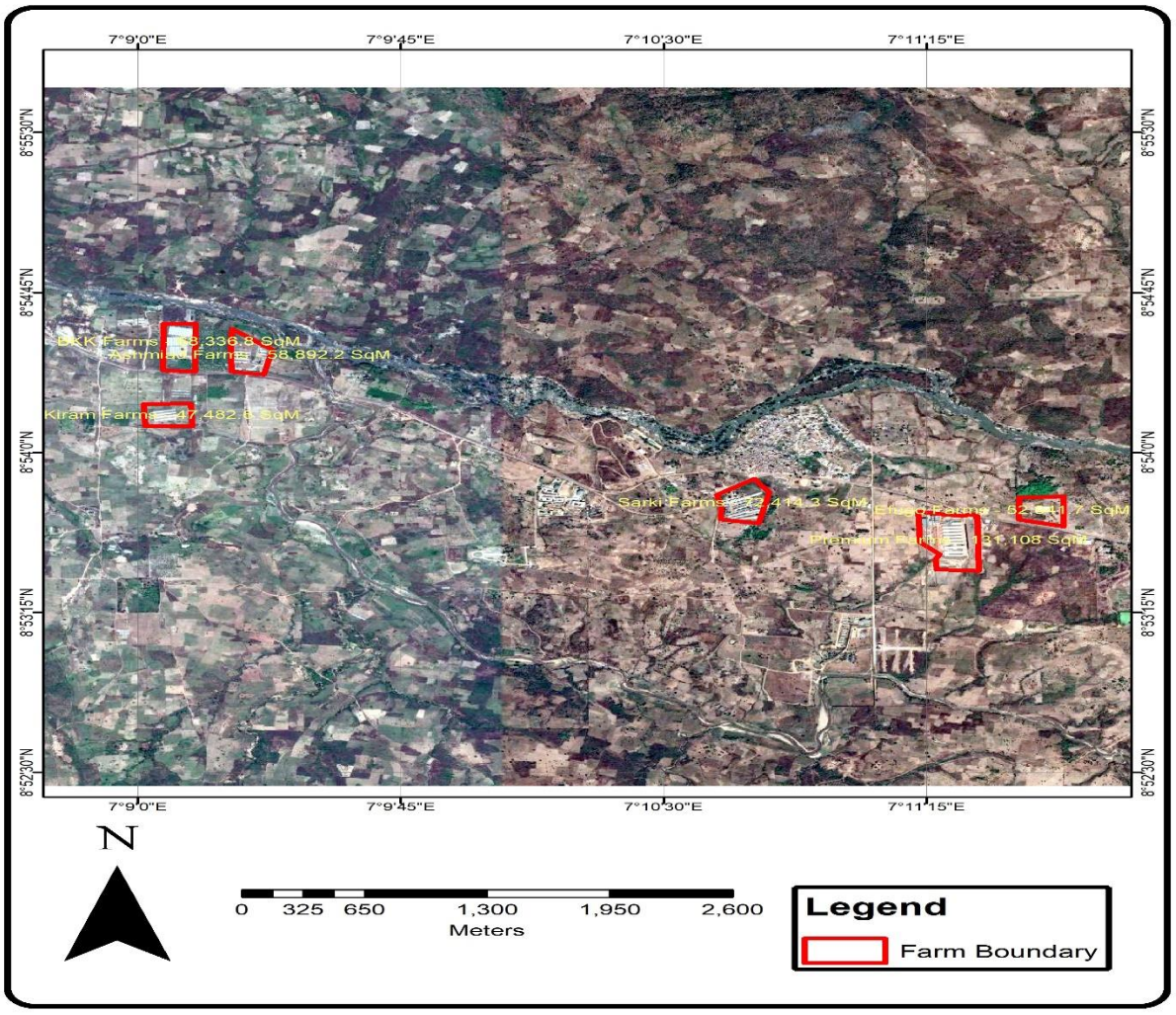

Figure 2: Poultry Farms and adjoin community in 2020 Satellite Imagery

Data Collection and Analysis

Water samples for physical and chemical properties were collected with clean pre-washed three (3) litre bottles for surface water, borehole and well water using hand sampling method. purposive sampling was applied to create the sampling points of borehole water and well water based on nearness to residents while the river/surface water is the only existing one. During the sampling, the bottles were first rinsed with the sampled water before the actual sampling. Samples of water were collected one (1) litre each making total of three (3) bottles labelled surface water, borehole water and well water respectively (Figure 2 and table 1). The following parameters were measured using (Standard Methods) 19th edition APHA, AWWA, WEF, 1995 for water analysis. The pH, Conductivity, Calcium, Total Alkalinity (TA), Total Hardness (TH), Nitrate (NO3), Phosphate (PO4), Sodium (Na), Potassium (K), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) Manganese (Mn) and Total Dissolved Solids (TDS) of the water samples were determined according to standard methods in the Central Services Laboratory of the Department of Water Resource and Soil Sciences, Federal University of Technology Minna. The average means of the parameters measured were compared with the WHO/ NESREA and Federal Ministry of Environment (FMENV; 2008) regulatory standards and guidelines to determine extent of water pollution.

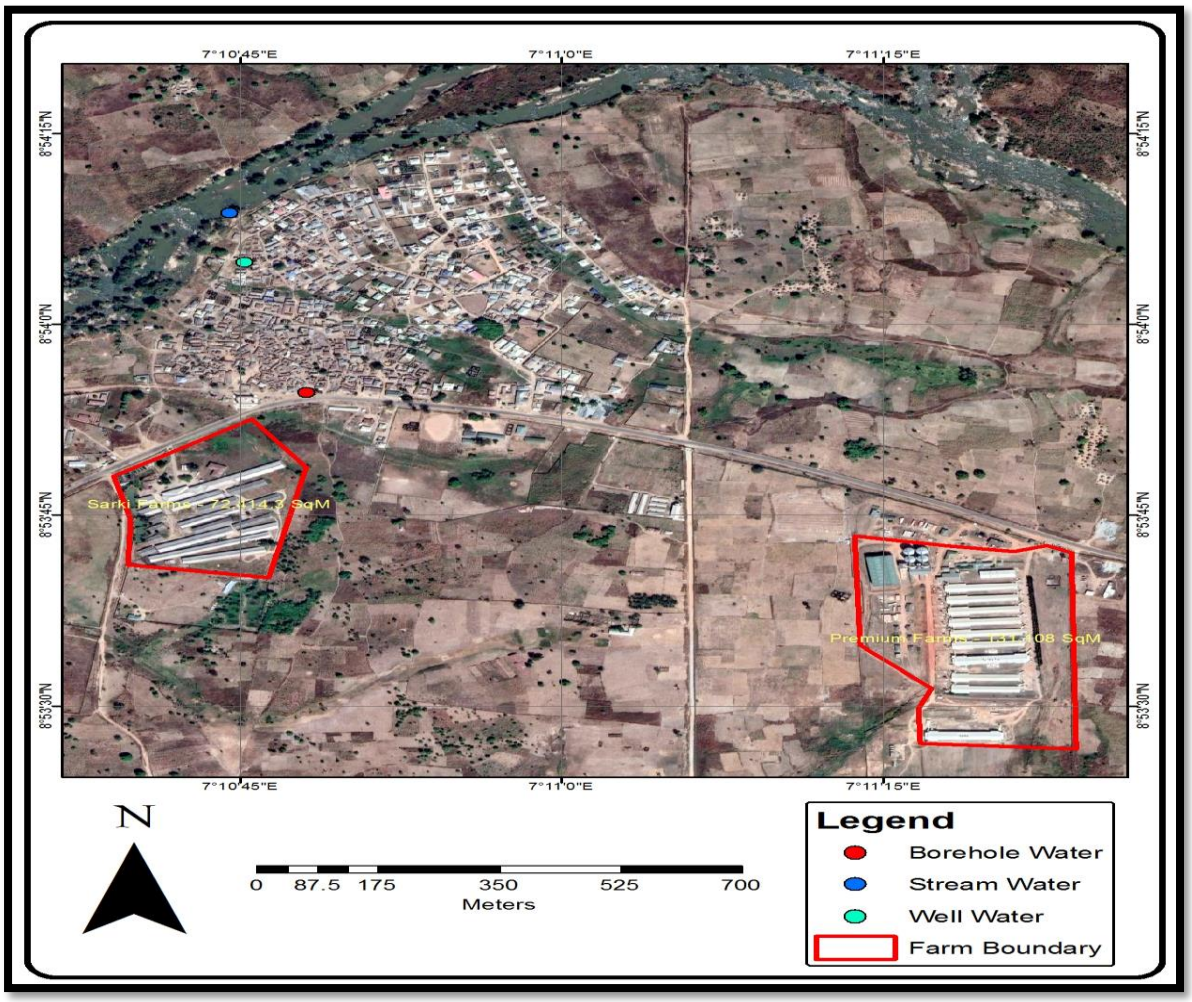

Figure 2: Satellite Imagery of Water Sampled Locations

Table 1: Water Sampled Points with Coordinates

s/n	Sample code	Coordinates
1	Surface water	0299850^{o}E; 0984437^{o}N
2	Borehole water	0299930^{o}E; 0984011^{o}N
3	Well water	0299875^{o}E; 0984320^{o}N

Source: Authors Field Survey, 2020

4.0 RESULT AND DISCUSSION

Impact of poultry farm on surface water Quality

The impact of poultry farms on water quality in Kuje sub-urbian was assessed through laboratory test analysis of sampled surface water, borehole water and well water to determine the physiochemical parameters. The result is compared using the World Health Organization (WHO; 2011), National Environmental Standard and Regulation Enforcement Agency (NESREA ;2011) and Federal Ministry of Environment (FMENV; 2008) standards and guidelines.

Table 2 present the result of the test analysis on the samples - surface water, borehole water and well water. The analysis results reveal the presence of some concentration of heavy metals above the WHO/NESREA recommended standard. The laboratory test results show presence of high concentration of Total Alkalinity in surface water with average mean score of 82mg/l, Borehole water (MS=169mg/l and well water (MS = 45mg/l), all above the WHO benchmark of <5.5mg/l. Similarly, high concentration of Manganese was observed in the sampled water above the recommended 0.05-0.5mg/l. The surface water shows 7.12mg/l concentration of Manganese, Borehole water (MS=6.64mg/l and well water (MS = 6.80mg/l). Also, high concentration Phosphate was observed in the sampled water above the recommended 0.5mg/l. The concentration of Phosphate in surface water is 0.13mg/l, Borehole water (MS=2.24mg/l) and well water (MS = 1.94mg/l). Similarly, concentration of Nitrate in the surface water is 2.19mg/l, Borehole water (MS=3.44mg/l and well water (MS = 5.6mg/l) above the 0.2mg/l recommended standard for water quality. Biochemical Oxygen Demand (BOD) are significantly above the WHO/NESREA standard. The BOD was found in surface water (6.76mg/l) and well water (8.27mg/l) above the benchmark of <5mg/l.

The study findings reveal the potential toxic of water contaminants including TA,Mn, ph, and NO3–, resulting from the impact of poultry farms activities in Kuje Suburbia. The findings are in line with other studies (Soldatova et al.,2018; Kalhor et al.,2016).

Table 1: Physiochemical the Analysed Result of Water Quality in Kuje Suburbia

Parameters	**Mean Sample Score**			**WHO/NESREA Guidelines**
	Stream Water	Borehole Water	Well Water	
pH	6.73	6.82	6.76	6.5-8.5
Conductivity	148uSiemen	304uSiemen	388uSiemen	1000uSiemen
Total Hardness (TH)	50 mg/l	65mg/1	70mg/l	50-200mg/1
Total Alkalinity	**82mg/1**	**169mg/l**	**45mg/l**	<5.5mg/1
Calcium	21.09mg/l	37.82mg/1	42.1mg/l	75mg/1
Manganese	**7.12mg/l**	**6.64mg/l**	**6.80mg/l**	0.05-0.5mg/1
Sodium	2.83mg/l	5.96mg/1	3.54mg/l	200mg/1
Potassium	0.66	1.44mg/1	0.78mg/l	200mg/1
Phosphate	**0.13mg/1**	**2.24mg/1**	**1.94mg/l**	0.5mg/1
Nitrate	**2.19mg/1**	**3.44mg/1**	**5.6mg/1**	0.2mg/1
BOD	**6.76mg/1**	3.50mg/1	**8.27mg/1**	5mg/1
COD	9.23mg/1	16.65mg/1	16.65mg/1	80mg/1
TDS	31.46mg/l	64.71mg/l	93.63mg/l	500-2000mg/l

Source: Authors Field Survey, 2020.

5.0 CONCLUSION

The study has shown that the poultry farms activities have adverse impacts on their environment in Kuje sub-urbian. Findings reveals high concentration of heavy metals in water by activities of the poultry farm in Chibiri community. Thus, the poultry farms are source of environmental pollution in the area and constitute public health challenge. Water quality (drinking, domestic purposes, food production or recreational purposes) has an important impact on public health. Water of poor quality can cause disease outbreaks and it can contribute to background rates of disease manifesting themselves on different time scales (WHO, 2020). Initiatives to manage the safety of water do not only support public health, but often promote socioeconomic development and well-being as well. The study therefore, suggests the need for appropriate authority to determined and enforced distance between poultry farms and residences to mitigate the effects of environmental pollution /health hazards especially with the experience of the COVID 19 global pandemic. Government and the Poultry farms should embark on public enlightenment campaigns to the residents around the poultry farms, with a view to educate them about the negative impacts of their operations to the health and wellbeing. In addition, review of the existing planning approval system and development environmental management plan to reduce negative impacts of the poultry farms and ensure compliance to good management practice.

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An Analysis of the Relationship between Neighbourhood Ties and Crime Perception in Minna, Niger State

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Abstract

Studies have shown that neighbourhood ties are significant in crime reduction, the lack of neighbourhood ties limits the capacity of neighbourhoods to regulate and control behaviour which contributes to higher rates of crime. Prevention of crime has taking a significant part of our lives, as many people in our urban centres and cities today worry about crime, ensuring doors are locked when leaving the house, installing CCTV and security alarm or avoiding a high crime neighbourhood. This study therefore assesses the relationship between neighbourhood ties and resident's perception of crime in Minna. The study employed quantitative approach using structured questionnaire. Total of 420 residences were randomly sampled from eight (8) neighbourhoods in Minna. Spearman correlation analysis was used to examine the relationship between neighbourhood ties and resident's perception of crime. The study found that that there is a moderate negative significant relationship between neighbourhood ties and resident's perception of crime in Minna (rho= -.399, p= <.01). This implies that the higher the level of neighbourhood ties the lower the resident's perception of crime in Minna. More importantly, the study however found that neighbourhood ties had different effect in different types of neighbourhoods in Minna. Specifically, neighbourhood ties significantly and negatively had relationship on resident's perception of crime in high density neighbourhoods, while it had no significant relationship on resident's perception of crime in medium and low-density neighbourhoods. The study findings suggest that strengthening of neighbourhood ties among residents will go a long way in controlling residential neighbourhood crime as much as possible. This study serves as call to urban planner and government agencies towards achieving sustainable neighbourhood's development.

Keywords*: Neighbourhood ties, Crime prevention, Sustainable Neighbourhood.*

INTRODUCTION

In every five years, 60% of the cities inhabitants has been victims of one form of crime or the other and over half of these crimes occurred in our neighbourhoods (Emmanuel & Lizam, 2015). According to Alapata (2012) the concentration of crimes in major urban centres has been an indicator of breakdown of our urban systems. Every city needs its own strategy or approach to tackle the menace. Therefore, there is a need for every individual city to establish a unique and effective framework to prevent neighbourhood crime (Alapata, 2012). Numerous research has been carried out on crime prevention though environmental design (CPTED) has shown that the higher level of neighbourhood maintenance and structural design measures has contributed to the prevention of crime in neighbourhoods, but the role of neighbourhood social aspect (neighbourhood ties) on crime prevention has been less researched (Johnston *et al*., 2005).

Neighbourhood ties have long been concerned as the ability to control and reduce crime. The inability of neighbourhoods to develop strong ties is a key predictor of high level of crime (Wickes *et al.*, 2017). It is well established that crime is concentrated in neighbourhoods that are socially lacking (Faust & Tita, 2019). Neighbourhood ties thrived in societies where there is a common goal and a mutual sense of belonging. Such sense of belonging and common vision has been shown to help reduce the likelihood of crime in an urban settings regardless of socio-economic status, lifestyle and neighbourhood characteristics (Olutola, 2016). When residents feel connected to each other, they work together to resolve local problems, leading to lower rates of crime (Wickes *et al.*, 2019).

Concept of Neighbourhood Ties

Neighbourhood ties is an evolving concept, that is subject to multiple meanings (Holdsworth & Hartman, 2009). The concept of neighbourhood ties is viewed as a characteristic of society dealing with the connections and relations between societal units such as individuals, groups and associations as well as territorial units. The sociologist Emile Durkheim, was the first to use the concept. He considered it as an ordering feature of a society and defined it as the interdependence and solidarity between members of a society (Berger-Schmitt, 2000).

As noted by the Australian Bureau of Statistics (2004) neighbourhood ties refer to the social and community commitments that bind people together. Council of Europe (2008), defined neighbourhood ties as the capacity of a society to ensure the well-being of all its members, minimizing disparities and avoiding marginalization. The broad definition of neighbourhood ties set out by the United Kingdom Local Government Association (UK LGA, 2002), is one that promotes common vision and a sense of belonging, appreciation of diversity of backgrounds and circumstances, similar life opportunities for all people not dependent on background, community where strong relationships can be developed between people from diverse backgrounds.

The definitions have brought to fore some challenges that have thrown up a number of conceptualizations or adoption of neighbourhood ties as contributory unified factors to society. These generally include features that are related to individual behaviours and social attitudes, which comprise of established characteristics of communities that are known to be obligatory for cohesive society (Mekoa & Busari, 2018). The societal attitudes and behaviours that are commonly invoked include, having a sense of belonging that translates or give semblance of common identity (these includes national identity, absence of impunity, respect for the rule of law and inclusiveness); ability to tolerance and respect individual's feelings and opinions, tribes, race, culture, religions and avoidance of culture of impunity in the system, Presence of mutual trust and confidence in other individuals that could booster inter-personal and institutional trust, having a somewhat civic co-operation, provision of good governance and eradication of corruption, an active participation in matters of national interest and respect for the constitution by abiding and respecting law (so as to ensure a significantly low or absence of crime in the society).

METHODOLOGY

The Study Area

Minna is a metropolitan settlement and the administrative capital of Niger State, lies within latitude 9°24ˈN and 9°48ˈNorth and longitude 6°25ˈE and 6°45ˈEast. It is about 120km away from the Federal Capital Territory, Abuja through the F126 Minna-Suleja road. Minna is with a population of 317, 465 according to the 2006 census (National Population Commission, 2006). The land mass size is about 6,784 square kilometres encompassing of residential neighbourhoods and political wards (Kawu, 2016). Minna has twenty six (26) neighbourhoods (Badiora *et al.*, 2017) that were identified on the basis of population density, environmental qualities and other socio-economic attributes (Kawu, 2016). Minna neighbourhoods are classified into three densities (low, medium and high). Figure 1 shows Minna and neighbourhoods.

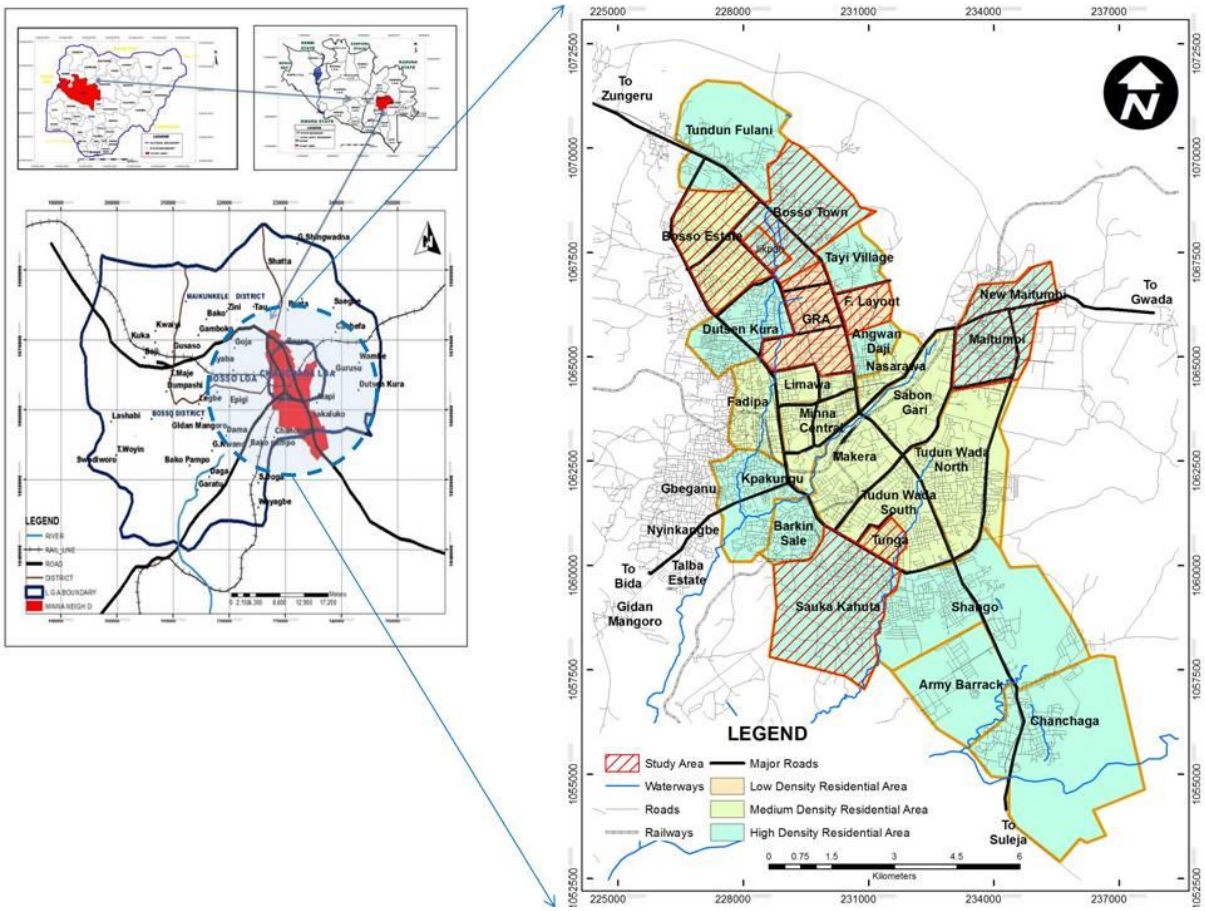

Figure 1: Minna the Study Area

Data Collection

This study relied on primary data which involves a structured questionnaire that was used to obtained data from residences in selected neighbourhoods using a cross-sectional survey. Population of the study (n = 420) were collected from residents of 8 selected neighbourhoods using stratified random sampling out of twenty-six (26) neighbourhoods in Minna based on densities (Low, Medium and High). The selected neighbourhoods include Bosso Town, Jikpan, Maitumbi (High densties), Sauka Kahuta, Tunga and Bosso Estate (Medium densities), F-Layout and GRA (Low densities).

Table 1: Distribution of Sample Size (n)

S/N	Neighbourhoods		Estimated Household size	Sample size (n)
	Name	Density		
1	Bosso Town	High	11,360	208
2	SaukaKahuta	High	1,107	20
3	Maitumbi	High	4,604	84
4	Tunga	Medium	1,682	31
5	Jikpan	Medium	151	3
6	Bosso Estate	medium	1,682	31
7	F-Layout	Low	1,711	31
8	GRA	Low	667	12
	Total		**22,964**	**420**

Measures

A total of twenty-seven (27) indicators identified from literatures were used in assessing neighbourhood ties and were derived form sense of belonging, community engagement, neighbourliness, socio-economic attribute and access to facilities/services (Table 2). The categorical response for each item ranged from 1 (strongly disagree) to 7 (Strongly agree). Data on resident's perception of crime, respondents were asked to rate the occurrence of crime in their neighbourhoods.

Table 2: Indicator Used in Assessing Neighbourhood Ties

Indicators
Sense of Community
1. I look after my neighbour's children/properties when they are not around.
2. I value my neighbour/people view/comments in this neighbourhood.
3. When there are problems in this neighbourhood they are solved by the people.
4. I am happy living among people in this neighbourhood.
5. People in this neighbourhood always share important events such as birthday parties, weddings, and festivals.
6. People in this neighbourhood care about each other.
7. I really feel that I am part of this neighbourhood.
8. I can trust the people in this neighbourhood.
9. I feel this neighbourhood is good to live in.
Sense of Belonging
10. I can identify most of the people in this neighbourhood.
11. Most of the people in this neighbourhood knows me.
12. I always participate in activities in this neighbourhood.
Community Engagement
13. I belong to a group/clubs in this neighbourhood.
14. I attend events in this neighbourhood.
15. I do voluntary work in this neighbourhood.
Neighbourliness
16. I interact with my neighbours.
17. I visit my neighbours.
18. I offer support/help to my neighbours.
Socio-Economic Attribute
19. Age limit.
20. Marital status.
21. Educational qualification.
22. Type of occupation.
23. Income status.
24. Length of stay in the neighbourhood.
Access to Facilities/ Services
25. This neighbourhood is planned and well layout.
26. There are available facilities/services in this neighbourhood.
27. I use these facilities/services in this neighbourhood.

Data Analysis

Spearman correlation is a non parametric test that is used to measure the degree of relationship between two variables. Spearman correlation analysis with two tailed test of significance was conducted using SPSS version 24.0. Spearman coefficient (rho) technique was used to determine the strength and direction (negative or positive) that was met between

neighbourhood ties and resident's perception of crime. The most accepted view about Spearman coefficient is when rho = 0.10 to 0.29 as small, that is, it accounts for 1% of the total variance, rho = 0.30 to 0.49 as moderate, accounts for 9% of the total variance and rho = 0.50 and above as large, accounts for 25% of the variance (Field, 2006).

RESULTS AND DISCUSSION

Relationship between Neighbourhood Ties and Residents Perception of Crime in Minna

Table 3 presents the result of the spearman correlation analysis. It reveals that there is a negative and significant relationship between neighbourhood ties and resident's perception of crime in Minna (rho= -.399, p= .000) indicating a moderate relationship. The implication of this relationship is that the higher the neighbourhood ties, the less the resident's perception of crime in Minna.

However, correlation on each neighbourhood density (high, medium and low) was calculated separately. The table show there is only significant relationship between neighbourhood ties and resident's perception of crime in the high density neighbourhood of Minna (rho= -.459, p= .000). This could be due to different levels of neighbourhood ties and resident's perception of crime in the neighbourhoods.

Table 3: Correlation between Neighbourhood Ties and Resident's Perception of Crime in Minna

	Minna	**Neighbourhood Density**		
		High	Medium	Low
Correlation Coefficient	-.399**	-.459**	.221	-.061
Sig. (2-tailed)	.000	.000	.077	.699
N	420	312	65	43

**. Correlation is significant at the 0.01 level (2-tailed).

CONCLUSION

This study is a contribution to the concept of sustainable development. Presently, the concept of sustainable development is likely the most well-known and generally used theoretical framework for assessing the living condition in a society. A socially sustainable neighbourhood includes element of social ties, safety and security among. Therefore, social sustainability in this study is the quality of being in a place (neighbourhood) that is capable of providing and maintaining neighbourhood ties and safety. The findings recommended that significant programs aimed at promoting sustainable neighbourhood development should consider strengthening neighbourhood ties among residents to lead to crime free residential neighbourhood. Although the study offers several contributions, however, further study is needed to establish the association between neighbourhood ties, resident's neighbourhood satisfaction and neighbourhood crime in Minna.

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User Centred Approach to Interactive Architectural Spaces For Sustainable School of Architecture Buildings in Nigeria

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Abstract:

Design studio, still the center of curricular program in architectural faculties worldwide, and considered the standard for education in architectural design. The architecture studio's main role in the current academic framework of architectural study however, needs to be rethought. Therefore, redirection to architecture studio design is required to achieve an atmosphere that provides an immersive and collaborative sense of setting for studio users. Just as architecture design studio is seen as a learning environment and usually an area where interactions occur, the function of architecture is to build and develop spaces that meet the needs of architecture users, and the use of spaces to different individual and group of people. This paper explores the techniques and goals of architectural design for open space facilities that provide stress relief for learning environments like those of university campuses in a compact urban setting. The literature reviews together with the input of experts indicate strategies for integrating sustainability as the basis for achieving a functional institutional environment structure for the Nigerian schools of architecture thereby, this is the basis for the creation of a questionnaire to gather relevant data. From improving quality and better service delivery in terms of improved interactive space organization. The findings indicate the integration of sustainable building spaces into architects' theoretical preparation. The study recommends that it is important to establish guidelines for an alternative design approach that is focused on the user and at the same time strengthen the training of student architects by creating more interactive spaces.

Keywords: Collaborative Learning, Design Studio, Interactive Spaces, User's Centred Approach.

INTRODUCTION

The design studio lives at the heart of architectural learning by a well-established pedagogical process of 'learning by doing' builds Core insight for learners. Learning in architecture are certainly inadequate. Architectural design teaching means different things for different people; each instructor teaches appropriate to their own developed ideas and values and in a manner different from others. Meanwhile, a large number of areas of focus, teaching methods, and facilities are present in various faculties and even within a single faculty (Salama, 2006). In spite the achievements of developing studios to serve as a powerhouse, gushing out revolutionary ideas, imaginative thinking and measurable results of social and cultural vitality, linking the most knowledgeable, committed researchers with a broad range of new knowledge. There's a bigger problem in that, many students in their university life are subject to high levels of stress.

Hamaideh (2011) noted that the stressful life of the university also threatens academic performance among students. In this context, campus design is far beyond giving study space. It should also be healing serving both physical and emotional needs. Thus, the issues of sustainable development need to be incorporated into the institutional context for architectural teaching and practice in order to promote interaction and collaboration between students through the dual role of social engagement and environmental enhancement reinforcing each other jointly, featuring an open space in healthy campus life. The research focuses on the institutional framework of Nigeria's Architectural Schools and the sustainability objectives as an integral part of that framework. The emphasis is on how to build open spaces to alleviate stress among students and encourage healthy campus life interaction and collaboration. The goal of the study is to suggest strategies for integrating sustainability for achieving functional

buildings for schools of architecture in Nigeria. This is to improve quality and better interactive spaces for architectural learning.

LITERATURE REVIEW

In educational spaces and classrooms, architecture plays an important role; it is therefore appropriate to give users physical and psychological comfort in school times. Physical concerns have usually been taken into account from the environmental psychological viewpoint and are named as a container in which human actions and interaction take place and the emotional, social, psychological and physical needs of users are addressed. However, space can lead to serious harm to physiological and psychological needs of human beings (Lang, 2012). Throughout past research, student self-concept, teacher education, teaching process, the school environment and government have been established as factors that influence student academic success, and the primary environment of the students. This stress is described by Lee and Larson (2000) as an interaction between environmental stressor, the student evaluation and its reactions.

Though optimum stress may improve performance, too much stress may cause physical and psychological disease, decrease self-confidence and can affect students ' academic achievements. According to statistics released by the National Crime Records Bureau, one student commits suicide every hour (Saha, 2017). Open spaces are often intended to promote interaction by providing an environment for formal and informal activities. Open spaces situated between buildings and function as joints of surrounding environments provide a sense of direction in a campus by integrating and coordinating different places and elements; they can also provide an aesthetic meaning by involving attractive surroundings and generating visual surprises. Through outdoor spaces, many creative and innovative concepts take place, away from structured lessons and discussions. The natural scenery and the calming environment in the open spaces encourage impromptu meetings and conversations, and provide fresh air for stressed scholars (Payne, 2009).

Evans and Mccoy (1998) established that architecture through stimulation can affect human health. It has been generally acknowledged that creative expression can be encouraged by an open and informal environment but the relaxation that an open space provides must be mild. To accommodate individual desires and social interaction, the environment must be versatile. This also needs to provide protection or defense against discomfort and overstimulation. A well-designed open space would create an integrated combination of private space for focused research and public space for interactive interactions within campus life. Stress is also present when changes or disturbances in the physical environment trigger difficult prediction. Hence, open spaces need to be coherent. Coherence refers to consistency, or ease of understanding. Ambiguity, confusion, and disorientation are huge barriers to coherence. Strange (2001) and Kenney and Daniel (2005) opined that important principles for a healthy learning environment are located in open space on campus.

Open areas can encourage teamwork and encounters by chance, as well as a less formal and more casual approach to work. There are ways in which the design of a space will affect the occupants' mental health. A fundamental concept for designing open space on campus is to provide a meaningful place for basic student needs such as warmth, relaxation and social interactions such as a well-designed breakout area with comfortable seating and even walking meeting routes may inspire students to be more involved and spice up their work atmosphere. It is important to remember in designing solutions that campus has several buildings with different open space characteristics. All academic organizations have the same spatial layout,

but public and private areas must be included in the outdoor design. The study of open spaces on American campuses leads to issues of the design of large common areas and special courtyard places and space among buildings in more than one location (U.S. Council on Education, 2006).

Spatial experience quality must respond to user needs and support campus users' efficient, simple, secure, enjoyable, exhilarating experiences. Dober, 2000 asserted that the principles of spatial quality in campus design are fluency between indoor and outdoor spaces, suitability for the realization of student events, flexibility of usage and comfort for any user. Also studies have shown that a well-designed and linked indoor and outdoor campus networks can be central, but usually ignored catalysts in student learning and is a powerful influence on the initial and long-standing experiences of students that foster a sense of belonging to the learning community (Greene, 2013). Numerous studies on spatial features have shown, in addition, a relationship between these features and the desire of people, and the instinctive need for protection and survival even of human beings. Established relations were verified again and again, having been investigated by different researchers.

According to Garling (1969) spatial features in architectural spaces include space size, movement and circulation in space. Meanwhile Tanner (2009) opined that daylight and optimum visibility affect students' performance. While Lau and Yang (2009) expressed that the courtyard could be ideal for a relaxed sense of space as well as number of open sides. Having reviewed influences of learning spaces that impact student achievement, evidence was gathered of landscape effect on people's wellbeing, from ancient times to the present day (Velarde et al., 2007). These factors include the belief that viewing vegetation, water, and other natural elements can reduce stress (Ulrich, 1984). Amount of window view of nature enhance self-discipline increased and stress reduction (Taylor et al., 2002). Building conditions such as light, colour, temperature, air quality, acoustics, school size and furniture have a direct effect on the actions and performance of the students.

Another important learning factor is sufficient provision of green areas. It offers space for exercise; space to experience nature; space for regeneration of body, mind and soul; and space for peaceful social interaction. Musavi (2006) found that among the environmental factors affecting campus performance includes the class feature in terms of heat, silence, lighting, furniture, facilities and cleanliness. Hence, for improve efficiency in educational environments attention to the environmental conditions such as the appearance of plants in the classroom can boost the performance of students and can also be used as an educational tool (Daly, 2010), Natural environment features such as tree views, nature reserve alleviate stress and improve mood (Hartig et al. 2007). Additionally, garden with fruit trees and a variety of floral species could likewise increase powers of concentration (Ottosson and Grahn 2005) alongside window shadings. This paper focused on two main assumptions as stated below

Hypothesis 1:

H0: There is no association between the user centered design and collaboration among the level.

H1: There is an association between the user centered design and collaboration among the level.

Hypothesis 2

H_0: There is no association between the functionality design and collaboration among the level which is prompted by the nature of space.

H_1: There is an association between the functionality design and collaboration among the level which is prompted by the nature of space.

METHODOLOGY

This paper adopted quantitative research approach to source for data concerning architectural design studio interaction.

The survey Instrument

From initial observations and preliminary conversations with architecture students, an image of the key issues and conditions affecting their performance in their studies was obtained, from which a questionnaire was designed in line with their need for interactive spaces. The questionnaire comprised of closed questions with yes/no answer options as well as questions with pre-defined answer categories, with the possibility for multiple responses in some questions. The use of a questionnaire being considered as the most appropriate tool by which the most economical, reliable and prevalent method of collecting the necessary information could be easily reached by the respondents. The questionnaire was administered to architectural students within the selected school environment. This enhanced the correctness and validity of the results.

The Survey

The use of questionnaire survey was considered appropriate for this study in order to reach a large number of respondents concerned. It was also used as an objective method to obtain opinions on the issues to be investigated. Akande et al., (2018) adopted a similar approach in their study to investigate the respondent's perceptions of public building projects in Nigeria. Prior to administration of the survey, the questionnaire was piloted using the expected, standardized questionnaire to ensure that the respondents could easily understand before it was considered appropriate to collect the required data. The sample for the survey was drawn predominantly from department of architecture in Nigeria and the respondents chosen using random sampling techniques. The questionnaires were designed online on google form and sent to the respondent through the use of social media such as Email, WhatsApp and Facebook. The survey instrument was carried out from August to October 2020.

Reliability Test

In order to determine the reliability of the measurement scales used for analysis for this study, the data was analyzed and reliability tests were carried out. Using Cronbach's standardized alpha (Table 1), the reliability of the instruments was obtained to ensure unidimensionality between the test scales. From the data set, 14 variables were observed because these are the variables with numeric values and the reliability coefficient of all 14 parameters is 0.878. This implies high reliability of the data.

Table 1: Reliability Test

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.875	.878	14

Relative Importance Index

Relative Important Index was calculated and each observation was ranked and the most important ones was identified. The dominant factors were required to define and assist decision making of policymakers for guidance in the integration of the approach to interactive space design. To accomplish such a feat, accurate prevalence data is therefore required. The use of the Relative Importance Index (RII) was considered as one of the means by which such prevalence can be determined.

Data analysis method

Descriptive statistics were used to evaluate the responses obtained from the questionnaire and to summarize the socio-demographic data while statistical analysis was performed using

statistical package for social scientists (SPSS) to analyze the problems identified in this research.

Findings and Discussion

Socio-Demographic Characteristics of the Respondents

A total of 177 responded to the survey. Therefore, the sample size is considered adequate. Result obtained shows that 27% of the respondents are female while 73% are male. Very few (18.6%) of the respondents are from age 15-19 while 44.6% are from age 20-24. Meanwhile, 31.6% are from age 25 - 29 while 5.1% are age 30 and above. This finding indicates that the majority of the respondents were matured and capable of providing the foundation needed for understanding design approach for interactive spaces. Based on the institutions surveyed, findings obtained shows that 65.5% are from Federal University of Technology, Minna while 26% are from Federal Polytechnic Bida both in Nigeria. It was observed from the findings that among the respondents, only 55.9% have open space designated to enhance student interactions while 44.1% do not have open spaces to enhance student interactions in their institution.

Contribution of design features in facilitating interactive spaces

The contribution of each of the design features was examined and the ranking of the attributes in terms of how it enhances the student's learning as perceived by the respondent was carried out by determining the Relative Importance Index (RII) using the formula below:

$$RII = \frac{\sum W}{A * N}$$

Where W = Weight given to each statement by the respondent
A = Highest response integer which is 5
N = Total number of respondent

Result from Table 2 shows that user centered design ranked first, followed by functionality as the second and fostering connection as the third.

Table 2: Design features in facilitating interactive spaces

Design features	Relative Important Index (RII)	Rank
User Centered Design	0.6350	1
Flexibility	0.5887	4
Fostering Connection	0.6079	3
Blended Learning	0.5016	5
Functionality	0.6090	2

Integration of Interactive Spaces

The findings obtained as presented in Table 3 reveals that the respondent ranked "Interaction ease design process in studio" as first. This was followed by "achieving a common goal from collaborative work using interaction" ranked as the second. This implies that integration of interactive spaces is considered a factor to enhance learning. Meanwhile "awareness of the collaborative work attributes and condition from interaction" ranked third.

Table 3: Integration of Interactive Spaces

Integration of Interactive Spaces	RII	Rank
Aware of the collaborative work attributes and condition from interaction	0.7401	3
Achieving a common goal from collaborative work using interaction	0.7468	2
Individual's use of other member's feedback and critics for improving their works	0.7209	4
Collaboration from interaction brings about free rider	0.6858	5
Interaction ease design process in studio	0.7638	1

Importance of interactive spaces

According to the findings obtained from Table 4, the respondent perceived that among the importance of interactive spaces, "collaboration among the level which is prompted due to the nature of space" is ranked first. Meanwhile "student are less productive due to stress in the campus" is ranked second. Studio connection to each other was ranked least, this may be due to the fact that studio connection may not necessarily has to do with spaces that may enhanced learning.

Table 4: Importance of interactive spaces

Importance of interactive spaces	**RII**	**Rank**
Stressful environment prevents interaction amongst students	0.7638	3
Collaboration amongst the level is prompted due to nature of spaces	0.8158	1
Studio connected to each other enhances easy interaction amongst students	0.7615	4
Students are less productive due to stress in the campus	0.8101	2

To test the assumption of the study, the following shows the findings from the test statistics carried out.

Hypothesis 1

H0: There is no association between the user centered design and collaboration among the level.

H1: There is an association between the user centered design and collaboration among the level.

Table 5 shows that there is an association between user centered design and collaboration among the student's level of study which allows them to perform to their highest and best potential as well as minimize superfluous distractions. Chi-square test of independence (Table 6) was used to test if the dependent variable affect or influences the independent variable for this findings.

Table 5: Association between user centered design and collaboration among the level.

			[User centred design (learning spaces to allow students to perform to their highest and best potential and to minimize superfluous distractions.)]			Total
			Low	Moderate	High	
[Collaboration amongst the level is prompted due to nature of spaces]	Disagree	Count	11	7	0	18
		Expected Count	4.5	6.6	6.9	18.0
	Neutral	Count	15	14	10	39
		Expected Count	9.7	14.3	15.0	39.0
	Agree	Count	18	44	58	120
		Expected Count	29.8	44.1	46.1	120.0
Total		Count	44	65	68	177
		Expected Count	44.0	65.0	68.0	177.0

Table 6: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	28.785[a]	4	.000
Likelihood Ratio	33.272	4	.000
Linear-by-Linear Association	28.225	1	.000
N of Valid Cases	177		

a. 1 cells (11.1%) have expected count less than 5. The minimum expected count is 4.5.

Result from Table 6 above shows that the asymptotic significant value is less than 0.05. Therefore, we reject the null hypothesis and conclude that there is an association between the user centered design and collaboration among the level which is prompted by the nature of space. When there is a learning spaces to allow students to perform to their highest and best potential and to minimize superfluous distractions this will influences collaboration among students. Since there is an association between user centred design and collaboration among the level, the level of association was measured (Table 7). Judging by the Gamma (Goodness and Kruskal's gamma) the association is strong. The association is statistically significant with a value of 0.584.

Table 7: Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	.352	.059	5.536	.000
	Gamma	.584	.084	5.536	.000
N of Valid Cases		177			

a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.

Hypothesis 2
H_0: There is no association between the functionality design and collaboration among the level which is prompted by the nature of space.
H_1: There is an association between the functionality design and collaboration among the level which is prompted by the nature of space.

Table 8 shows that there is an association between the functionality design and collaboration among the student's level which allows the spaces provided to accommodate all participants comfortably, and to ensures that each proposed use of the space can be hosted without putting stress on the room or disquieting users. Similarly, Chi-square test of independence (Table 9) was used to test if the dependent variable affect or influences the independent variable for the findings below.

Table 8: Association between the functionality design and collaboration among the level

			[Functionality (Space to accommodate all participants comfortably, and to ensures that each proposed use of the space can be hosted without putting stress on the room or disquieting users.)]			Total
			Low	Moderate	High	
10 [Collaboration amongst the level is prompted due to nature of spaces]	Disagree	Count	13	5	0	18
		Expected Count	5.7	6.2	6.1	18.0
	Neutral	Count	14	13	12	39
		Expected Count	12.3	13.4	13.2	39.0
	Agree	Count	29	43	48	120
		Expected Count	38.0	41.4	40.7	120.0
Total		Count	56	61	60	177
		Expected Count	56.0	61.0	60.0	177.0

The Asymptotic significant value is less than 0.05 therefore we reject the null hypothesis and conclude that there is an association between the functionality and collaboration among the level. When there is a space to accommodate all participants comfortably, and to ensure that

each proposed use of the space can be hosted without putting stress on the room or disquieting users will affect or influences collaboration among students.

Table 9: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	19.557[a]	4	.001
Likelihood Ratio	23.265	4	.000
Linear-by-Linear Association	16.901	1	.000
N of Valid Cases	177		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.69.

Since there is an association between functionality design and collaboration among the level, the level of association was measured (Table 10). Judging by the Gamma (Goodness and Kruskal's gamma) the association is strong. The association is statistically significant with a value of 0.436.
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Table 11: Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	.254	.064	3.821	.000
	Gamma	.436	.102	3.821	.000
N of Valid Cases		177			
a. Not assuming the null hypothesis.					
b. Using the asymptotic standard error assuming the null hypothesis.					

DISCUSSION OF FINDINGS

Student interaction will increase from our findings if Architects take into account the above-mentioned factors when designing learning environment. The main stress problems are those which architects do not take it into consideration when designing as observed from the analyzed data. This study showed that well-positioned open space strategies and elements would not only minimize stress but also improve collaboration, resulting in better academic performance. The figure above shows the factors that improve student interaction in the campus setting as defined by the respondents. The application of user centred design in Spatial design, functionality of Landscape design, and Green design fostering connection have been selected according to the report. Based on the findings in the study in order to increase interaction among students from the inception stage of the design, the architect should have proper knowledge stress reductions. They should be abreast with all the changing trends in identifying interactive spaces in order to make proper decisions that will increase interaction and collaboration and reduce stress. This will give value to the learning environment and help increase the student's academic performance, confidence and creativity. It is also recommended that more detailed research should be done on student's perception that influence the learning environments. User's centred approach should be applied at the initial stage of design in order to foster connections.

CONCLUSION

Reviewing has shown the new method of learning and the development of technology focusing more on the spatial complexity, green informal gathering spaces and landscape in learning processes that led to a new system of educational spaces and created a new open environment in which interactions are encouraged within students themselves and teachers, encourage collaboration and strengthen communication rates which would change the way people feel and behave while studying or working within the building environments. The need for

interaction spaces from formal classical classrooms to informal circulation areas and open spaces is therefore advocated, and the efficacy of their design has become central in university buildings and an important factor in making university buildings a functional tool for the community. The learning space should depict learning and teaching purposes, support the school mission, integrate technology, and be adequately flexible for non-class ends. Informal collaborative spaces are certainly significant.

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Integration of Interactive Spaces in the Design of an Autism Centre, in Kaduna State, Nigeria

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Abstract:

Autism spectrum disorder is characterized by the inability to meet social, educational and occupational demands starting from early developmental stages to later stages in life. When it comes to taking care of the "specials" in under-developed nation, an individual with Autism Spectrum Disorders gets less care. Research indicates that the traditional conventional curriculum design frameworks often fail to address the spatial and sensory needs of children with ASD and other cognitive differences. The aim of the study is to integrate interactive spaces in the design of Autism Centres in Kaduna State to enhance the management and treatment of people with Autism Syndrome Disorder. The researcher used Descriptive research method and Purposeful sampling method. A total of 76 questionnaires was distributed and 68 were returned. The information gathered was analyzed using SPSS version 21. The variables examined were based on the users' expectations. Results suggested a high degree of dissatisfaction with the quality of facilities available in the centres with mean score of 1.8, and with the number of interactive spaces with mean score of 1.44. The respondents, in contrast, were pleased with the location's upkeep and security with mean values of 3.0 and 2.59 respectively. It is critical to ensure that the building is effective, comfortable, and fit for all, particularly autistic patients, in order to improve the development of patients with autism. Provision should be made for various types of spaces depending on their various purposes, as this would assist in improving space usage.

Keywords: Autism Spectrum Disorder, Sensory Design, Interactive spaces, Integrate, Management.

INTRODUCTION

Autism Spectrum Disorders (ASD) describe a group of Neuro-developmental conditions in which the individuals face challenges with social engagement, age-appropriate play and fail to develop appropriate peer relationships according to their developmental level (Samadi and McConkey, 2011). ASD is characterized by the inability to meet social, educational, and occupational demands starting from early development stages to later stages in life. Autism affects children developmental ability causing social, communication and behavioural challenges (Yates *et al*., 2016)**.**

This research assessed the integration of interactive spaces adopted in the design of Autism Centre in Kaduna State with the view to highlight the potential benefits derived from interactive spaces and proffer better and sustainable ways on how to integrate interactive spaces in the design of Autism centres. It also exposed part of what is takes for an ASD patient to live a well, using un-orthodox means to compliment other care and management process. Considering the various types of facilities/centres in Kaduna state, this research focuses on facilities with autism care and management within Kaduna metropolis of Kaduna State, Nigeria. Kaduna state is the choice area for this research because with an estimated population of over three million and the development pace of this city, official facility for autism management is a dire necessity.

ASD in Nigeria

The greatness of a nation is often measured by the premium of care it places on its weakest members. Currently, Nigeria does not have a policy in place for neuro-developmental disorders, probably because most are hidden, despite the fact that no social class or economic status is spared (Oshodi *et al.*, 2016). In Nigeria, one out of every 125-150 children is living

with this condition. This amounts to about 600,000 Nigerian children (Oshodi *et al*., 2016). The burden this places on the patient, his/her family, the society, and the nation at large is unquantifiable. The greater cost is the loss in harnessing the potential in individuals with autism spectrum disorders due to inaction and neglect.

Autism Spectrum Disorders ASD was first identified in Nigeria in the 1970s (Franz *et al*., 2017). A study by Bakare and Munir (2011) suggested a prevalence rate of 0.08%, acknowledging that this may be artificially low due to the very limited attendance of children at clinics for childhood developmental disorders. More recently, Lagunju *et al*. (2014) reported a prevalence rate of 2.3%, with five times as many males as females identified, while Chinawa *et al.* (2016) suggested a prevalence rate of 2.9% among school children in South East Nigeria.

Architecture and autism

Despite its overwhelming incidence, autism is largely ignored by the architectural community, excluded from building codes and guidelines, even those developed specifically for special needs individuals. Various building codes of practice have excluded specific requirements for designing for autism. Among these are three documents published by the Department of Education and Employment in the UK (Architects and Building Branch, Department of Education and Employment). The first two documents "Access for Disabled People to School Buildings" and "Designing for Pupils with Special Educational Needs- Special Schools", make no reference to specific guidelines when designing for autistic users, while "Inclusive School Design Accommodating Pupils with Special Educational Needs and Disabilities in Mainstream Schools". Children with challenging behaviour display their frustration in different ways and Beaver opined that when designing a building you don't know at the time that the occupants are going to be and even if you did, they would change as time went on (Barker, 2014). Hence, architect or designer should consider a building for autism, whether residential or educational, will not just be occupied by the children but also by their guiders or teachers.

Sensory Design

Sensory design is the design for living which encompasses how space feels, sounds, looks, smells, and functions which can incredibly affect one or more of the seven senses which can have an overwhelming effect on life (Society, 2015). With the environment playing a huge impact on a child with Sensory Sensitivity; their senses can be either over-developed (hypersensitive) or under-developed (hyposensitive) which can result in feelings of anxiety, physical pain, stress & occasionally. Hypersensitive and hyposensitive can have an impact on how a child handles different environments (Barker, 2014).

The key to designing for autism seems to revolve around the issue of the sensory environment and its relationship to autistic behaviour (Mostafa, 2014). Sensory Design Theory has been applied to countless fields to better understand and meet autistic needs (Mostafa, 2014). Due to the knowledge that fulfilment of individuals' needs is essential to designed physical learning environment to meet students' basic needs through acoustic, colour, smell, lighting, accessibility, way finding, compartmentalization, scale of the building, quiet room, safety, garden and alternative (Mostafa, 2008; Vogel, 2008; Altenmüller-Lewis, 2017).

Research done by Paron-Wildes (2005) explained that when designing children's environments, it is important to consider the needs of children with neurological disorders and to think through spaces as an experience. He explored with individuals suffering from problems with sensory integration or sensory defensiveness and revealed that autistic does not typically fall in the "normal" or "average" range of sensory values that are experienced, (Society, 2015).

Observation by Goodyear (2014) described two basic principles: the first is looking at autism as a sensory processing issue, and the second is defining architecture and design as the primary sources of the majority of sensory input in the built environment. When designing areas for patient with autism spectrum, it is important to have knowledge and understanding of how they experience the environment because it is also important to know that not all children are affected in the same way or to the same range (Scott, 2009).

Interactive Spaces

Interactive spaces are vital in promoting healing while offering a safe and comfortable environment to signal permanence and confidence, to achieve a delightful, pleasing and healthier environment (Fottler *et al*., 2000). This gives the patients a feeling of still being at home, assist in the treatment of the physical body and support the spiritual needs of the visitor; these two factors create a sense of holistic healing and relaxation. Various healing principles, adopted mainly from healthcare design will support the goals mentioned above. These will include the integration of spaces, colour theory, connection to nature, light, texture, and forms.

Therapeutic healing means a state of complete physical, mental and social wellbeing which is influenced by an individual's health, to restore health or cause an undesirable condition to be overcome, through positive effect on the body, mind and environment for a disease or ailment. It is a process of revitalization, relaxation and release at a profound level, which contributes to the well-being, recovery and healing of a patient and can reduce stress and stimulates the self-recovering ability of the patient (Bovenberg *et al*., 2010). Interactive spaces assist in the treatment of the physical body and Support the spiritual needs of the patients and visitors. These two factors will create a sense of holistic healing and relaxation (Fottler *et al*., 2000).The healing principles stated below will be adopted during the planning and design stages of the paediatric facility to support the goals mentioned above through artwork on walls, and machines, provision of interacting spaces, bright and controllable light fixtures, and the use of landscaping elements. Through the integration of a.) Colour Theory, b.) Connection to Nature, c.) Light, d.) Texture and e.) Forms (Coates, 2001).

METHODOLOGY

The research focuses on facilities for autism care and management in Kaduna metropolis of Kaduna State, Nigeria. Descriptive research method was employed for the purpose of this research and Purposeful sampling method used to select the sample size. A list was gotten from the Kaduna Ministry of Education showing schools and centres with autism management within the State showing a total of seven known centres, of which five was located and the remaining two could not be located because of possible change of address amongst other reasons. The Population size was estimated at 80 consisting of teachers and caretakers from the five centres selected and Sample size estimated at 66 using Morgan's Table of Samples. Table 1).

Table 1: Names of centres studied with questionnaire distribution

S/N	NC	PTC	PP	QD	QR
1	A.I.M Special Children Centre	24	30	23	21
2	H.M.S Schools	12	15	11	10
3	Danbo International Schools	19	24	18	16
4	Essence International School	16	20	15	13
5	Open Arms Children Development Centre	9	11	9	8
Total		80	100	76	68

Key: NC= Name of centre PTC= Population of teachers and caretakers, PP= Percentage of population, QD= Questionnaire distributed, QR= Questionnaire returned.

A total of 76 questionnaires were administered to cater for errors amongst the five (5) selected centres in the study area based on measures of frequency after which 68 were returned. The data collected was fed into SPSS version 21 where it was analyzed using descriptive statistical tools, such as measures of central tendency (mean) and measures of frequency (percentage) and cross tabulated. One observation schedule was per centre by the researcher alongside the questionnaires distributed.

RESULTS AND DISCUSSIONS

Assessing the Various Interactive Spaces in the Centres

From observation, 87% of the interactive spaces were for learning and recreational purpose, even though there are cases of inadequacy and inefficiency of the functionality of the facilities. While 13% the centres had their interactive spaces serves combined function of circulation spaces, nature spaces and recreational spaces. The functions in the interactive spaces however are not well defined using equipment and facilities. Majority of them are just plain open allowing users to put them into whatever use they desire. Provision should be made for various types of spaces based on their various functions as it can help enhance utilization of the spaces. Table 2 and 3 show the interactive spaces available at the centres as captured by the researcher using the observation schedule. The interactive spaces are located on the exterior, and in the interior parts of the buildings. They are usually in enclosed spaces, open, closed or semi-closed. These interactive spaces include: play pens classroom courtyards, atriums, hallways, balconies reception, playgrounds, lobbies, gardens, walkways, porches, and rooftops to mention but a few.

Table 2: Types of interactive spaces at location (interior)

s/no	Name of centre	Type of interactive space (interior)							
		courtyard	classroom	Atrium	balcony	hallway	Play pen	Indoor sports	Indoor pool
1	A.I.M Special Children Centre	✓	✓	x	x	✓	x	x	x
2	HMS Schools	✓	✓	x	✓	✓	✓	x	x
3	Danbo International Nursery School	✓	✓	x	✓	✓	✓	✓	x
4	Essence International School	✓	✓	x	x	✓	x	x	x
5	Open Arms Children Development Centre	✓	✓	x	x	✓	✓	x	x

Table 3: Types of interactive spaces at location (exterior)

s/no.	Name of centre	Type of interactive space (exterior)					
		Playground	Sport field	pitch	Green area	Terrace	Water body
1	A.I.M Special Children Centre	✓	x	x	✓	x	x
2	HMS Schools	✓	✓	x	✓	x	x
3	Danbo International Nursery School	✓	✓	✓	✓	✓	✓
4	Essence International School	✓	x	x	✓	x	x
5	Open Arms Children Development Centre	✓	x	x	✓	✓	x

Activities in the interactive spaces in the centres

Activities in the interactive spaces are usually active or passive. Active activities include physical rigorous activities like playing, walking, running and other sporting activities while

passive activities include sitting, relaxation, reading, viewing and other less physical activities. Passive activities are usually mental in nature while active activities like the name implies are physical and rigorous.

Major activity carried out in the spaces analyzed is playing, running, seating and walking (circulation). The spaces lack some important activities which is mostly due to the necessary facilities required for them are not in place. If these facilities are made available, children will be motivated to make use of the spaces.

Both active and passive activities are carried out in the spaces. Fig 1 indicates a 40% of combination of activities. Passive activities involved sitting, relaxation and gathering which is 20% percent and a combination of active activities like walking, sporting and playing, has 20%.

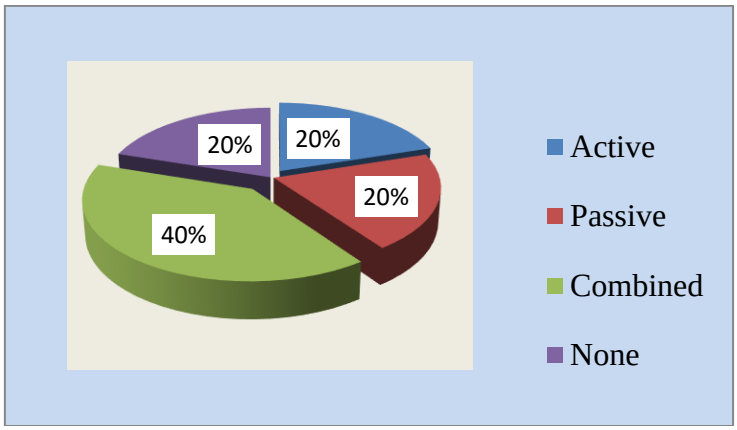

Figure 1: Type of Activities in the Open Spaces.

Passive Activities

Passive activities in spaces are unstructured and informal activities. Passive activity which is usually not rigorous encourages exposure to nature is restorative and beneficial to the health. Passive activities also enhance and maintain social interaction which encourages social cohesion.

Active Activities

Active activities in the spaces encourage active living for people. It provides physical, mental, psychological and other health benefits. Active activities carried out include formal outdoor sports and other organized sporting activities. Other activities include walking running and playing for kids.

Supporting Facilities within the interactive Spaces

Supporting elements such as fountains, sculptures, pergolas and gazebos are provided to compliment, enhance functionality of the interactive spaces improve the quality of the spaces and enhance aesthetic value of the interactive spaces. Only 22% of the centres provided sculptures in some parts of their spaces. 33% of the centres had gardens as part of their interactive spaces. 45 percent of the centres did not employ the use of these supporting elements in their interactive spaces. The importance of these supporting elements in interactive spaces cannot be overemphasized. They may also be used as reference point for the centres that greatly influence the degree of utilisation of the interactive spaces.

Respondent's Satisfaction with interactive Spaces.

The user's perception was analyzed using the Likert scale measurement. A score of 1 – 4 was allocated to their response as stated below:

Very Dissatisfied (DS) 1
Dissatisfied (D) 2
Satisfied (S) 3
Very Satisfied (VS) 4

Table 4: Number of respondents' opinion on satisfaction with interactive space variables

Variable	Very dissatisfied (VD)	Dissatisfied (D)	Satisfied (S)	Very satisfied (VS)	Total
Number of interactive spaces	40	26	2	0	68
Size of interactive spaces	39	17	10	2	68
Location of interactive spaces	4	24	24	20	68
Quantity of facilities available	27	23	9	9	68
Quality of facilities available	28	30	7	3	68
Maintenance of the spaces	12	20	20	16	68
Security in the space	13	15	29	11	68
Safety precaution within the spaces	15	25	15	13	68
Circulation through the spaces	16	13	31	18	68
Aesthetic quality	14	25	17	12	68
Landscape quality	6	3	41	18	68
Lighting	13	16	34	15	68

The number of opinions was multiplied by the score given to it in each section. The results of the calculation and total are shown at the end of the table. 4.2 Below.

The results are interpreted below:

1.0 – 1.49 very dissatisfied
1.5 – 2.49 Dissatisfied
2.5 – 3.49 Satisfied
3.5 And above very satisfied

Table 5: Sum and interpretation of respondent's response on satisfaction with interactive space variables.

Variable	VD X1	D X2	S X3	VS X4	Total	Mean Total/68	Interpretation
Number of interactive spaces	40	52	6	0	98	1.44	Very dissatisfied
Size of interactive spaces	39	34	30	8	111	1.63	Dissatisfied
Location of interactive spaces	4	48	72	80	204	3.0	Satisfied
Quantity of facilities available	27	46	27	36	136	2.0	Dissatisfied
Quality of facilities available	28	60	21	12	121	1.80	Dissatisfied
Maintenance of the spaces	12	40	60	64	176	2.59	Satisfied
Security in the interactive space	13	30	87	44	174	2.59	Satisfied
Safety precaution within the spaces	15	50	45	52	162	2.38	Dissatisfied
Circulation through the spaces	16	26	93	72	207	3.04	Satisfied
Aesthetic quality	14	50	51	48	163	2.40	Dissatisfied
Landscape quality	6	6	123	72	207	3.04	Satisfied
Lighting	13	32	102	60	207	3.04	Satisfied

The parameters observed in Table 4 and 5 above are interactive spaces variables analyzed based on the perception of the users of the interactive spaces. It is observed that the majority of them are dissatisfied with the parameters analyzed. They were mostly dissatisfied with the quality of facilities available in the centres which has a mean score of 1.80. Numbers of interactive spaces have mean scores of 1.44 indicating a high level of dissatisfaction. However, the respondents expressed satisfaction with the location maintenance and security of the interactive spaces in the centres observed with mean values of 3.0, 2.59 and 2.59 respectively. The interactive spaces are mostly courtyards within the buildings and can be accessed easily. They also expressed satisfaction with the circulation spaces provided within the interactive spaces with mean value of 3.04. The majority of the spaces are mostly used for circulation.

CONCLUSION AND RECOMMENDATION

Conclusion

Once autistic children starting their learning process, the quality of the environment in an autistic centre is important to avoid confusing and frustrating to the autistic mind. This is because autism is an extremely complex condition which affects each person differently and can benefit more from the input that the built environment provides. In order to enhance the development of patient with autism, it is important to ensure that the building is effective, convenient and fit for everyone to use, especially for autistic patient.

Many aspects of interactive space planning, development and management in autism centres in Kaduna are yet to be given a proper treatment. Hence, abuse of the use of space. Others include under-utilization, Inadequacy in of facilities, structures and elements, poor maintenance practice, inefficiency in design and of some design features (in adequate space, poor spatial configuration poor access and circulation pattern, in adequate passive security measures to mention but a few). Consequently, these are reflected in the nature of the interactive spaces and the activities the spaces are subjected to. There is very little provision for proper relaxation within the interactive spaces in the centres observed. Another reason for the underutilization is unattractiveness of the designs. These spaces have direct impacts on the built environment and can be beneficial to the direct user especially.

Recommendation

The required spaces should be defined and equipped with relevant structures to avoid misuse and abuse of spaces. Existing interactive spaces can also be enhanced and corrected with necessary facilities and incorporating design elements. Design features and elements synonymous to interactive spaces should also be incorporated during the design stage of the interactive spaces.

Although interactive spaces in autism centres are far from meeting the desired acceptable standard, issues of standard setting, provision, enhancement maintenance and management should be considered. There is need for proper management and maintenance of the interactive spaces in the centres

The necessary facilities should be put in place to encourage utilization of the interactive spaces. The use of soft landscaping elements such as trees, shrubs and flowers intelligently placed at strategic locations should be encouraged as they help make the environment serene and aesthetically pleasing while serving other purpose like supporting and enhancing passive security and circulation measures as well as helping in regulating the temperature of the spaces.

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Assessment of Green Design Strategies in Tech Innovation Hubs in Abuja, Nigeria

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Abstract:

Modern workspaces, their space requirements and function have changed over the past few decades. This can be attributed to economic, social, physical and technological changes in the corporate world. The growing use of Information and Communications Technology (ICT) and related technology has led to the emergence of a more innovative workspace. Hence, the task of developing a sustainable built environment is regarded as daunting challenge globally, due to the considerable pressure of human development. Nevertheless, the need to consistently maintain a healthy environment cannot be overemphasized especially as several natural habitats of plants and animals have been affected and damaged due to various changes which have occurred over the past years. This paper is aimed at investigating the application of the green strategies in existing tech innovation hubs in Abuja. The research process adopts a descriptive survey method which employs the use of observation schedules and an in-depth review of existing literature. A simple random sampling technique was used to select a total of five tech innovation hubs in Abuja this represented 50% of research population of 10 buildings. Findings from the study showed a low level of implementation and the integration of green design strategies in existing tech hubs buildings assessed. It is however pertinent to know that green strategies can be integrated to allow for a sustainable development in tech hubs. This paper concludes that the adoption of these strategies is very important in hubs so as to halt the rise in greenhouse gas emissions by reducing the energy requirement of these buildings and creating a healthier environment. It thus, recommends that the government should enact and enforce laws that encourage the integration of green design strategies in the design and construction stages of tech hub buildings.

Keywords: *Green design, Built environment, Innovation, Sustainability, Hubs.*

INTRODUCTION

Over the past few decades the space and functional requirement of workspaces have changed. This can be attributed to economic, social and technological changes in the corporate world. The growing use of Information and Communications Technology (ICT) and related technology has led to the emergence of a more innovative workplace (Njeri, 2010). With changes in how individuals work, think and adopt the use of technology, resulting in new models of workspaces. The continual breakthrough in technology has impacted and helped in shaping the physical work environment (Stallworth and Kleiner, 1996). There is increased importance being placed on group work and collaboration, leading to alterations in the scope, size, functionality and social relevance of workspaces ***(Coward, 2014)***. The open and shared nature of innovation is altering the nature of design. Accordingly, Ganesh (2015) defines a tech innovation hub as a workspace that offers subject-matter expertise on technology trends, knowledge and strategic innovation management, and industry-specific insights. It can also be a specific building or set of buildings where small start-ups can rent space alongside each other to share facilities and ideas (Friederici, 2014).

The challenges arising from the impact of climate change has increased the need to stimulate a more sustainable approach in the development of the non-green industries (Bribian *et al*., 2011). This vital issue has resulted in major stakeholders proffering possible solution on how to restore and protect the ecological system. More also, as world population continues to increase and economies grow bigger, apparently so is the strain on the available natural resources. Yudelson (2009) asserted that worldwide, the building industry accounts for the consumption of approximately 60% of the earth's raw materials. The consumption of these non-renewable mineral resources is detrimental to the environment, subsequently causing

degradation (Wadel, 2009). Tech innovation hubs often have large carbon footprints due to their huge energy requirement which contributes to the increasing level of atmospheric carbon emissions (Gil-Mastalerczyk, 2016). Consequently, there is a general consensus towards halting the rise in greenhouse gas emissions especially in urban centres. Furthermore, the world population is forecasted to reach 5 billion by 2030 according to United Nations Population Fund (UNFPA, 2013). A lot of this urbanization will unfold in Africa and Asia, bringing huge social, economic and environmental changes. Hence the need to adopt a more sustainable approach by incorporating green design strategies in tech hubs so as to proffer lasting solutions to greenhouse gas emissions which in the long run will not only endanger our planet but also its inhabitants.

Ancient Research Workplace

In ancient times, the early places of research understood the important role of nature fostering a place for thinking. One of such example is Plato's Academy which is founded in 388 or 387 BC (Stefan, 2006). The medieval monasteries of Europe were built by affluent landowner monks, these buildings were based on the classical system of the orders created a plan shape that was proportional and congruent. The analysing of this period's structures exposes the architectural implications of its design and its role in prompting creative thinking. In this instance further knowledge is elucidated from the study of a typical monastery.

The Contemporary Research Workplace

The period between 1900 to 1950 economic progress and the introduction of reinforced concrete and modular ceiling and grid systems, provided greater amounts of leasable business space as well as the creation of a number of business opportunities. (Stefan, 2006). The office environments were designed using open planning concept, with entry level employees being positioned together, based upon their function and department classification. Job titles and ranking resulted in a standard amount of space per employee. This hierarchy based floor plan allowed management to view employees from their desks as the open planning arrangement meant there were no boundaries within eyesight. The hierarchy based interior planning of the past has been eliminated from Tech hub designs (Wheeler, 2015). The shift in work related tasks to relying on technology meant a larger focus on independent efficiency. This caused the development of modular furniture systems which were flexible, easy to assemble, electrified and customizable (Oltra and Saint-Jean, 2009). The present office environments have been altered to cater for wireless technology, as well as adjustable settings. During this time, environmental sustainability and individual control over lighting and thermal comfort were important drivers in workplace design. Working hours have now become integrated to accommodate any person, anywhere with 24/7 operations. Telecommuting, hoteling, webinars, smart phones and downsizing are popular buzzwords which have been integrated into the technological workplace of today (Sloane, 2011).

The Rise of Innovation Hubs in Africa

In the last few years, the African continent has experienced a considerable rise in technological entrepreneurship. A lot of faith has been placed on grooming indigenes digital economy with the hope that it will serve as a catalyst for socio-economic development. As asserted by Saraswati (2004) that governments within the region are investing and building cities for tech entrepreneurs. Tech hubs in the continent have interestingly attracted a lot of attention from individuals, cooperate organizations and researchers alike. One amongst many is the recent visit of Mark Zuckerberg, the founder & CEO of Facebook to Kenya startup innovation hubs. The start-up ecosystem in Sub-Saharan Africa particularly has become more competitive in recent times. The theme "Made in Africa'' software has already been used in many projects, such as M-Pesa, before the initial visit to Nairobi of Mark

Zuckerberg. The mobile and web-based start-up, launched in 2007 by Safaricom, enables its users to carry out financial transactions and pay for products and services on their mobile phones without a bank account being required. The M-Pesa now stands for technological innovation from Africa, as it is used in Kenya and its neighboring countries. In the past nobody in the professional world would have connected sub-Saharan Africa with technological innovation, yet today's Silicon Savannah is used frequently in and around Nairobi to characterize the booming IT sector.

The Concept of Green Architecture

Green, Sustainable or Eco-friendly Architecture as used interchangeably by different authors refers to an approach to building that minimizes harmful effects on human health and the environment. The green architect or designer attempts to safeguard air, water, and earth by choosing eco-friendly building materials and construction practices (Roy, 2008). Construction projects generally require large amount of materials, energy and water resources and it produces waste in large amount (Sassi, 2006). In an attempt to comprehend the meaning of sustainability and apply its principles into practice, definitions according to different authors are identified. Osama *et al.* (2017) explained the word sustainability as being used with its current meaning to refer to what could be continued in the future whereas the concept of sustainability in architecture is not about creating structures that will simply last long but rather creating one that is responsive to the needs of the present. It attempts to reduce the negative impacts on the environment by saving energy through the use of materials consistent with the environment, especially the climatic conditions of the site (Damati, 2013).

Green Design Principles and Strategies

Green design principles are fundamental prepositions of sustainable development that guide designers to create buildings of high performance with less negative impact on the environment (Gil-Mastalerczyk, 2016). Each of the design principles entails a set of unique strategies that can be disaggregated, analysed and employed by architects to reduce the environmental impacts on buildings they design. In order to educate designers and meet the goal of coexistence, Kim (1998) broadly proposed three principles of sustainability in architecture namely; Economy of resources, life cycle design and humane design. Economy of resources is emphatic about the reduction, reuse and recycling of natural resources that are employed in buildings. Figure 1 shows the sustainable design principles proposed by (Kim, 1998).

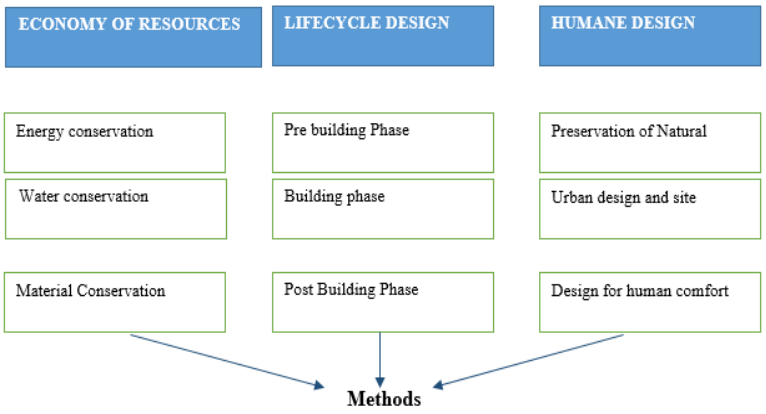

Figure 1: Sustainable design principles (Source: Kim, 1998).

Life cycle design provides a framework for analysing the building process and its negative impact on the environment. Lastly, humane design is based on human interaction with nature.

Passive design strategies

Passive design is an approach to design of buildings that depends on the architecture of the building to minimize the energy consumption of the buildings. Passive building elements such as the architectural, structural and envelope take cognizance of the environment to carefully optimize the building's envelope with the climatic conditions (Ragheb *et al.*, 2015). Passive solar design uses the following methods to achieve energy efficiency in buildings: Shape and form of buildings, Orientation of the facades to enable cooling and heating, Space planning, Natural day lighting and ventilation, Responsible landscape to reduce heat island effect, Thermal insulation, thermal storage of roof and walls and efficient site planning based on bioclimatic conditions.

Alternative sources of energy

A source of energy refers to source from which energy can either be directly extracted or recovered through processes of transformation or conversion. Generally, energy generation depends on the availability of resources and techniques of extraction. Also, energy generation is directly related to the needs of users, economic level and environmental impact (Attaman, 2010). Currently, the amount of energy required worldwide is far higher than what is being produced and more than 75% of the energy generated in 2035 will be based on fossil resources which are exhaustible and cannot be renewed (OECD, 2011). On this note, it has become imperative and critical to develop new ways of generating energy. The following sources of energy are not dependent on fossil resources, are sustainable and do not deplete the ecosystem, and offer great promise for sustainable development: Bioenergy, solar energy, geothermal energy, wind energy, hydro energy, blue energy, fuel cell energy and hybrid systems energy (Attaman, 2010).

METHODOLOGY

The descriptive survey method was used in conducting this study which employed the use of purposefully structured observation schedule to obtain relevant data for the study. A simple random sampling technique was used to select a total of five tech hubs in Abuja this represented 50% of research population of 10 buildings as obtained from Morgan's table of samples. The five (5) innovation hubs that were studied are; Aiivon Innovation Hub (Aiivon Hub), Ventures Park, Young Innovators of Nigeria (YIN Hub), Digital Development Hub (DDHub), Enspire Incubators Program (Enspire Hub). The elements that were observed include; orientation of the building, alternative source of energy, provision of courtyard spaces, atriums, high level windows, water conservation provisions, type of cooling and lighting systems adopted in the buildings.

Study Area

Abuja is Nigeria's Federal Capital and lies approximately between longitudes 6°46'E to 7°37'E and Latitudes 8°21'N to 9°18'N (Figure 2). It is bounded in the east by Nasarawa State, north by Kaduna State, west by Niger State and south by Kogi State.

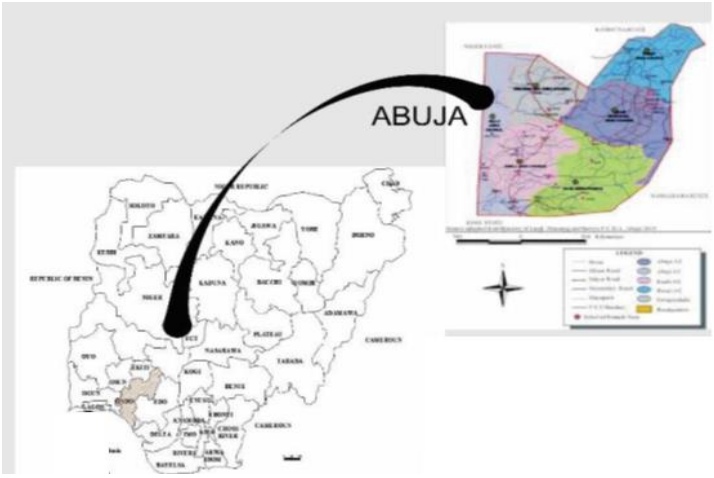

Figure 2: Nigeria showing the study area
Source: www.motherlandnigeria.com/geography.html

RESULTS AND DISCUSSION

From the observation schedule used, the result obtained was documented in tables and charts using the following representations.

1 – Available
0 – Not available.

Table 1 shows the orientation of the five buildings studied with regards to sunrise and sunset. In order to get good ventilation and adequate natural lighting, the buildings orientation is very critical as longer side ought to be along the west – east axis to reduce the amount of heat gain and hence ensuring little cooling is required to maintain good indoor comfort. Only two of the buildings studied are well oriented namely, YIN Hub and Enspire Hub. The other three (3) buildings were not properly oriented.

Table 1 Orientation of the Tech Hubs Buildings

S/N	List of Tech Hubs	North South	West - East	In Between
1.	Aiivon Hub	1	0	0
2.	Ventures Park	1	0	0
3.	YIN Hub	0	1	0
4.	DD-Hub	0	0	1
5.	Enspire Hub	0	1	0

The result reveals the alternative sources of power used by the tech hubs as shown in Table 2. Two of the five hubs make use of green renewable energy which is shown with the adoption of the solar panels. Only Enspire Hub rely of rechargeable batteries, however all the Five (5) building make use of generators which runs on petrol or diesel.

Table 2 Alternative Source of Power

S/N	List of Tech Hubs	Solar Panels	Recharge-able Batteries	Generator
1.	Aiivon Hub	1	0	1
2.	Ventures Park	1	0	1
3.	YIN Hub	0	0	1
4.	DD-Hub	0	0	1
5.	Enspire Hub	0	1	1

From the pie chart in Figure 3, it is observed that 100% of the buildings made effective use of vertical sun shading device, while 50% of the buildings use horizontal sun shading devices. The result shows that more than one type of sun shading device was adopted by the hubs.

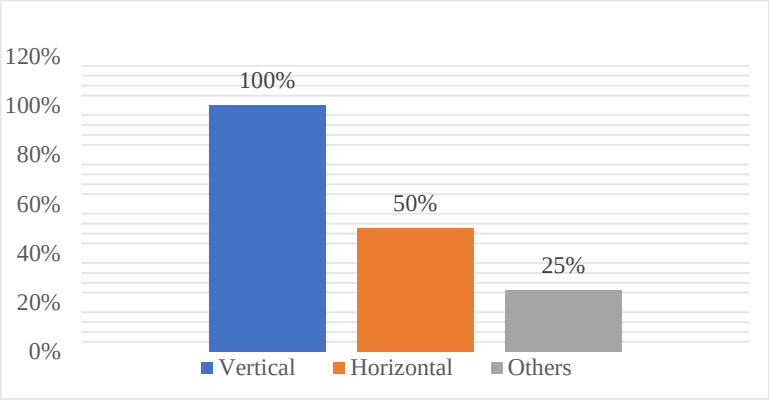

Figure 3: Sun Shading Devices used in the Buildings

The results from Figure 4 shows that courtyards have the highest frequency 40% as it was the most commonly adopted green outdoor space within the hubs, followed by gardens and covered porches, however sit-outs had the lowest 10% green spaces that was integrated in the design.

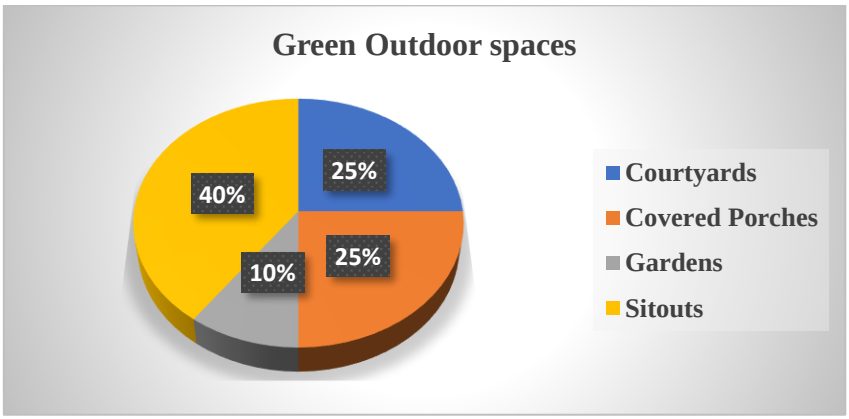

Figure 4: Green Outdoor Spaces

Plates 1 & 2: Indoor space with no access to natural lighting and ventilation at Aiivon and Enspire Hub.

CONCLUSIONS

The integration of green design strategy is considered as an effective way of negating the increasing greenhouse emissions due to the large energy usage of tech hubs. This strategy when

adopted helps in achieving good thermal comfort for the end users of these buildings by ensuring adequate natural lighting and ventilation. More also saving the need for more energy by taking advantage of other renewable sources of energy such as solar, wind and water. The study concludes that across the five case studies there was low-level of integration of green design strategies in the buildings and the impact of these strategies do not reflect in the energy requirement of the tech innovation hubs. Furthermore, the study shows that the tech hubs rely mostly on mechanical cooling and lighting systems as most of the spaces do not have a direct window opening to the natural environment. In the researcher's view this is partly due to the fact that three out of the five hubs buildings that were studied are not owned by the tech companies but rather they are rented. This explains the reason why the specific needs of the tech hub may not have been considered from the conceptual stage of the building design.

RECOMMENDATIONS

1. The study recommends the need for the government to enact policies that will encourage the adoption of green design strategies in tech hubs in line with what is obtainable in developed countries.
2. The research recommends that there is the need for sensitization of the professionals within the built environment on the benefits of adopting green strategies from design stage and construction stage to achieve rationalization of energy consumption in buildings.

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SUB-THEME 6:
GEOINFORMATICS FOR LAND MANAGEMENT

Solid Waste Disposal Site Suitability Analysis within Jalingo Metropolis, Taraba State, Nigeria

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Abstract

Waste disposal site selection in urban areas is a critical issue due to its huge impact on the economy, ecology and public health. In this study, site suitability for waste disposal in Jalingo metropolis were evaluated based on four criteria; road network analysis, drainage network, population and topographic features using GIS/RS techniques. The GIS software packages that were used for the research includes ILWIS3.7A and ARCVIEW 3.2A for geo-referencing and digitizing of map respectively, while IDRISI Taiga was used to buffer, overlay, reclassification, image processing and analysis using Boolean operations. the following constrain factors was adopted in this work; Distance from the road (300m); Distance from water bodies (1km); Distance from residential land use (3km); and elevation of the topography (100m to 200m height). The study revealed that extreme north-west of the metropolis and the north-east part of Jalingo were considered suitable. It was observed that the (31) existing dump sites didn't met the four criterion used for evaluation. Therefore, the pattern of the landfills was dispersed and unsuitable for waste disposal in the metropolis. The study recommends the establishment of new dump sites based on multi-criteria analysis using ARCGIS9.1 and that the State and Local Government Authorities concern to immediately stop waste disposal at the existing dump sites and relocate same to suitable areas.

Keywords: *Waste, Dump Site, Boolean operations*

INTRODUCTION

It is a settled law of nature that biological organization must essentially generate waste. It follows therefore that regardless of the social and economic stature, mankind must inevitably generate wastes of various forms (Tchobanoglous, 2009). Globally, the increasing urbanization has multiplied the quantity of solid waste generation in cities. In developing countries, it is common for municipalities to spend over 20 percent of the city recurrent budget on solid waste collection and disposal (Shafiulla, 2016).

Solid waste disposal in cities has become a major environmental challenge of which Jalingo metropolis is not an exception. These includes degradation to the physical environment and environmental health hazard such as disease transmission, offensive odours, pollution, inaccessibility to some of these dump sites for the evacuation of solid waste as well as lack of existing and up to date map of dump sites within Jalingo metropolis.

The spatial data on the location of dumpsites and site suitability of solid waste disposal which can easily be achieved with the use of Geographical Information System (GIS) is lacking. Hence, GIS provides a powerful technology for the spatial analysis of environmental factors. Application areas include assessment and mapping of environmental exposure, mapping of health outcome, and the analysis of spatial relationships between environment and health (Nakakawa and Ogao, 2007; Aderoju, et al. 2014; Kassah, et. al. 2016).

This study focuses on the development of GIS based solid water disposal site suitability analysis in Jalingo with a view to relocating existing dump sites which are unsuitable, through the following objectives: (i)To map and ascertain the distribution pattern of existing dump sites; (ii)To identify and analyze criteria for dump site selection; (iii)To verify site suitability of the existing waste dumpsites in the area.

LITERATURE REVIEW

Jensen and Christensen (1986) present an example of waste disposal site selection, based on a raster Geographic Information System. The study identify relevant constrains which includes government policy, site spatial characteristics, and preservation of endanger species. After determining these specific constraints, the needed environmental and cultural data are gathered. Manoliadis, 2002; Daneshvar, 2005; Morktar and Markson, 2006 studies corroborate that GIS is a suitable tool for site selection since it has the capability to manage large amount of spatial data that comes from various sources.

Ayeni (1998), demonstrated the capabilities of GIS for waste disposal site for Ajakanga sanitary landfill located in the periphery of Ibadan southwest Local Government Area, Oyo State. While, Aderoju, *et al*.(2014) used Geo-Spatial tool to analyse the spatial patterns of waste dump sites and the health hazards associated with it as well as identifying possible areas at risk of health hazards in Minna, Niger State, Nigeria.

The problem of locating proper waste disposal areas for cities, was studied by Akbari (2011). His work revealed that a proper waste disposal area is a function of many parameters including distance to urban and rural areas; distance to industrial and agricultural areas; distance to permanent and seasonal rivers; distance to faults; terrain slope; underground water level; transportation network; soil type; geology; and present and future land use of the area. This particular research applied Constraint Mapping Technique to reduce the search area over vast land coverage and to leave only those areas that are suitable for siting a landfill. The study shows how Geospatial Information Systems (GIS) was used to solve the problem of efficiently locating the potential waste disposal areas for Bandar Abbas, Iran.

In a similar study, Samiullah et al, (2016) worked on how to identify suitable sites for safe disposal of municipal and other solid waste generated in Peshawar City District, using GIS and Remote Sensing techniques. In his work, selection of suitable site depends on a number of factors to ensure environment friendly disposal of solid waste. The study used SPOT satellite image of 2010 and Topographic sheets as a base map in addition to the primary and secondary data acquired from various sources. They used multi-criteria analysis (MCA) in ArcGIS 9.3, and thematic map layers were generated for all the selected parameters using the spatial analysis tools. Based on the selected parameters; distances from residential areas, airport; water bodies; distance to spine roads; water table; land values; slope stability; and land use pattern, the entire Peshawar city district was divided into three regions of least suitable, moderately suitable and most suitable landfill sites.

In view of the above reviews, this study intends to develop a GIS veritable, powerful and suitable tool to provide an efficient and cost-effective means of analysing the suitability of existing dumpsites for waste disposal against manual methods that are tedious and time consuming.

The Study Area

Jalingo which lies between latitude 08° 43´N and 09° 07´N of the equator and longitude 10° 50´E and 11° 25´E of the Greenwich meridian as indicated (Figure 1) with population of 139,845 people in 2006 census and annual growth rate of 3.1%(NPC, 2006)

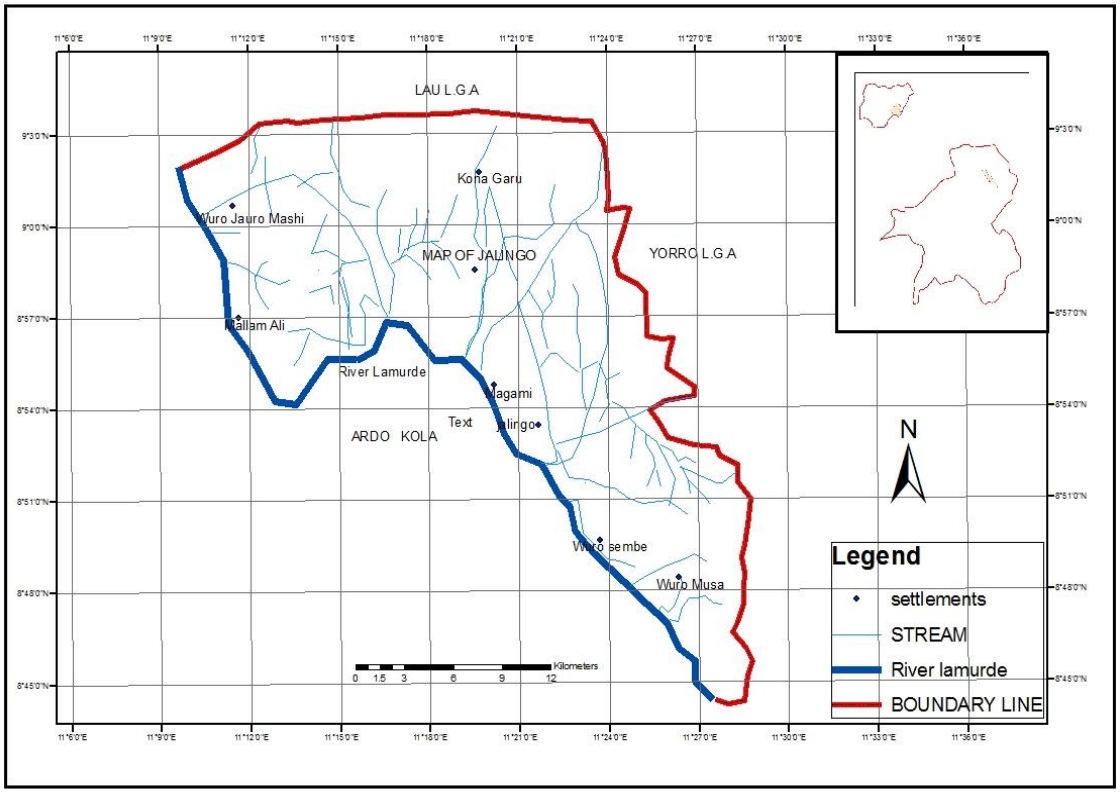

Figure 1: The Study Area (Source: Ministry of Land and Survey, 2014).

MATERIALS AND METHODS

Materials

This study is based on the collection of primary and secondary data. The procedure for data collection is as follows:

A topographic map sheet 215of 1:50,000 Scale obtained from Survey Department to delineate the boundary of the study area.; a Quick bird image of Jalingo 2014 was purchased for analysis; while SRTM of Jalingo was used to generate the drainage network and elevation map of the study area. A DGPS was used to capture the coordinates of the existing dump sites in Jalingo to ascertain distribution pattern and linked to produce suitable map for verification.

The GIS software packages that were used for the research includes ILWIS3.7A and ARCVIEW 3.2A for geo-referencing and digitizing of map respectively, while IDRISI Taiga was for all analysis such as buffer, overlay and reclassification.

Methods

The use of spatial operation such as buffer generation, polygon overlay, feature extraction and spatial search constitute the operation that were performed in this study in order to accomplish the stated objectives. The objective of this analysis is to select a suitable site for waste disposal in Jalingo and demonstration of scenario generation in environmental planning (Kassah, et al., 2016) The Topographic map sheet 215 was scanned as Tagged Image File Format (TIFF) using Corel draw- 12 and imported to ilwis environment and geo-referenced.

Criteria Development

The selection of suitable sites required different information about the geographical conditions of Jalingo city district. The four criteria considered in this work were: (i) The Waste Site must be at least 3km away from Residential Land-use; (ii) The Waste Site must be at least 1km from major Water Bodies; (iii) The Waste Site must be 300m away from Major Roads; (iv) The Waste Site must be between l00m and 200m height (Samiullahi, 2016**).**

D**ata Processing**

Thematic maps for each of the stated criteria in (i, ii, iii, iv) which include residential land use area (built-up areas) isolated from the land use map extracted from Quick bird image of Jalingo, drainage map, and road network map and the relief map of Jalingo extracted from Digital Elevation Model of Nigeria were each buffered through buffer module of ArcGIS according to the set criteria for suitability

The additional subroutine of the overlay modules of IDRISI Taiga was used throughout this work. The river buffer was considered first, with the built-up area buffer as the first two overlain maps. The two maps were overlaid to become "River-Built-up area Map". Any area that meet the condition (suitable) in both map will carry value "2", areas where only one of the maps met the condition and the same area on the other map carry value "3", while areas that did not satisfy the condition in both maps carried value "4" and reclassified to values "1"and" 2" for unsuitable area and suitable area respectively.

The road buffer was considered with the relief buffer as the second two overlaid maps. The two maps were overlaid to become "Road-relief Map". Any area that meet the suitability condition in both map will carry value "5", while other areas that did not meet suitability condition carry the values 4, 3, 2, 1 and reclassified to values "1"and "2"for unsuitable area and suitable area respectively.

Finally, the reclassified River-Built-up area map was overlaid on reclassified Road-Relief map to produce "suitable area map. DGPS coordinates of the (31) existing dump sites in Jalingo were collected and database was created, (see Appendix 1). The coordinate of the dumpsite was then link with the suitable area map to produce suitability verification map to validate the work.

RESULTS AND DISCUSSION

Results

Four criteria for site selection were set and results are presented in figures and text as follows:

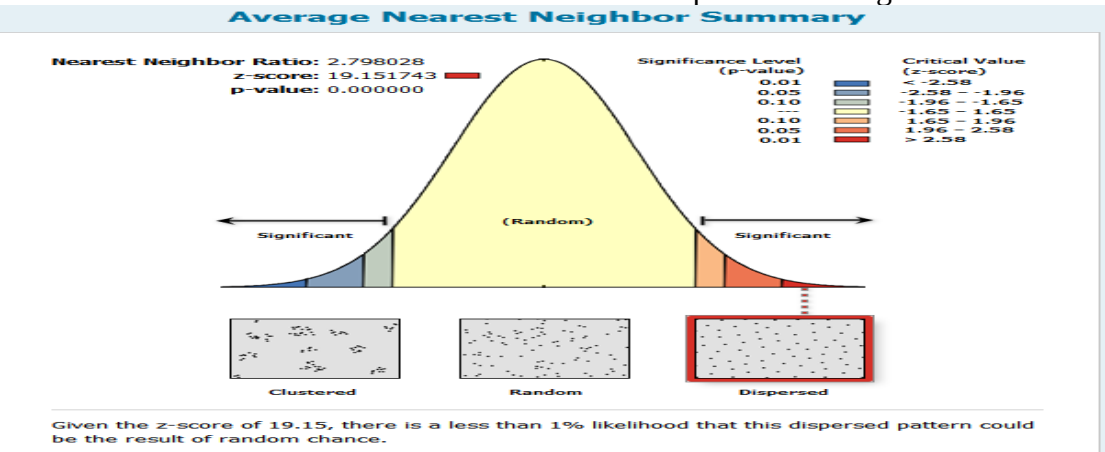

Figure 2: Average Nearest Neighbour Analysis (Existing Dumpsites Location)

Table 1: Analysis of the Nearest Neighbor

Average Nearest Neighbor Summary	
Observed Mean Distance:	3739.722259 Meters
Expected Mean Distance:	1336.556176 Meters
Nearest Neighbor Ratio:	2.798028
z-score:	19.151743
p-value:	0.000000
Dataset Information	
Input Feature Class:	Dump_sites
Distance Method:	EUCLIDEAN
Study Area:	221511419.000000

$Rn=Dm/D_E$

Where: Dm=observed mean distance.

D_E=expected mean distance.

E_D=expected mean distance.

De=1/2 square roots [p]

Where p=Density of points in the area, P=n/A

Rn=2DM square root [n/A] =2D square root

Where n=numbers of points in the area, $0< Rn < 2.15$

To determine the patterns of distribution of these dumpsite locations within the study area, the value of Rn after the analysis will be as follows.

If Rn=0 implies that the distribution of point is clustered.

Rn =1 implies that the distribution of points is random.

Rn=2.15 is regular

From table1 above, the nearest neighbour analysis of the distribution pattern of existing dumpsite locations in this research is dispersed.

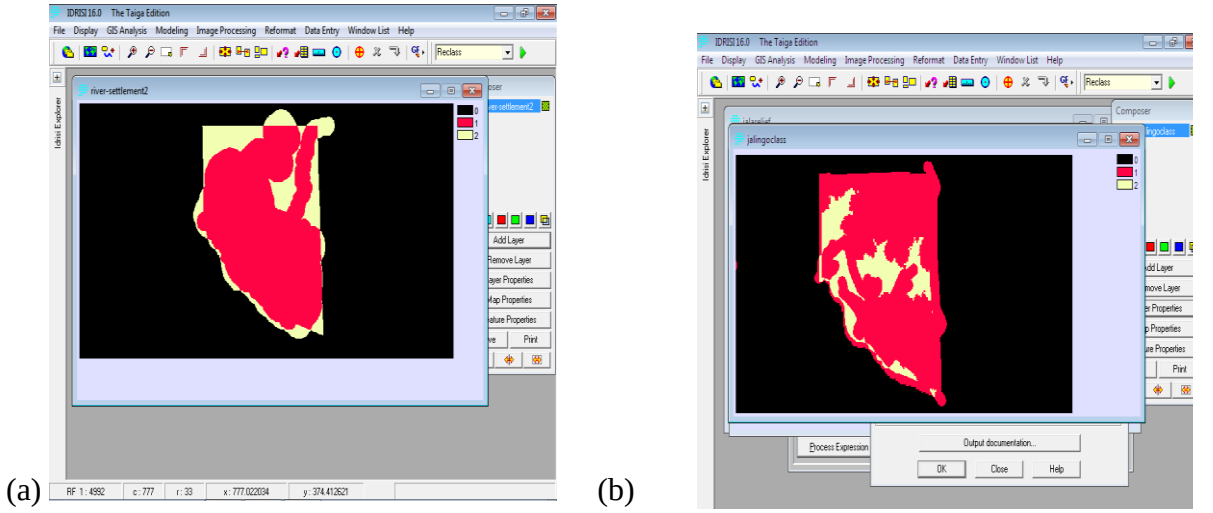

Figure 3: Map of Jalingo Metropolis: (a) Buffered River-Built-up Area and (b) Buffered Relief Road

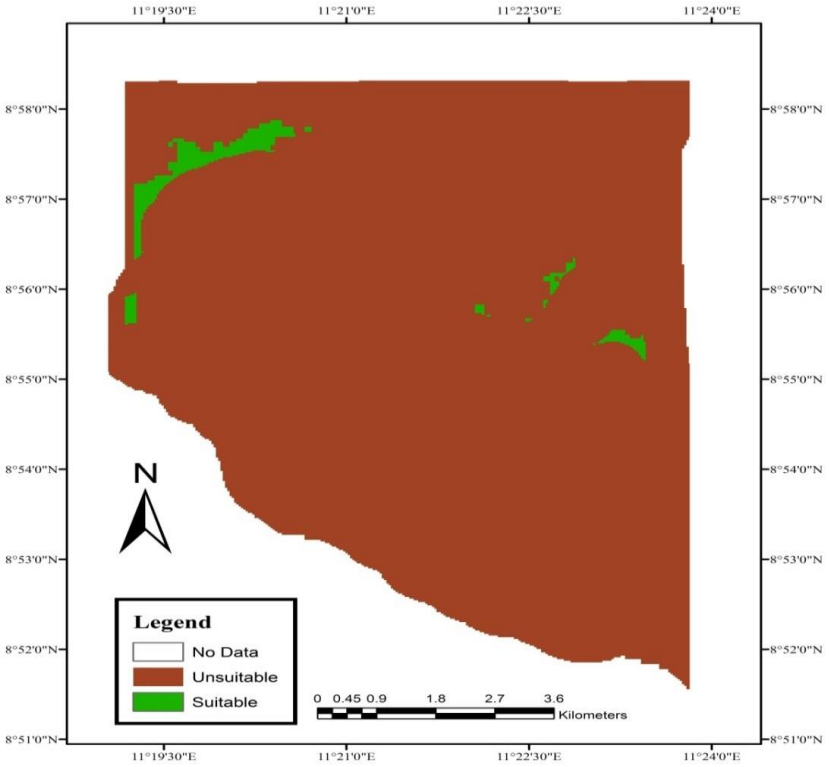

Figure 4: Suitable Area Map of the study area.

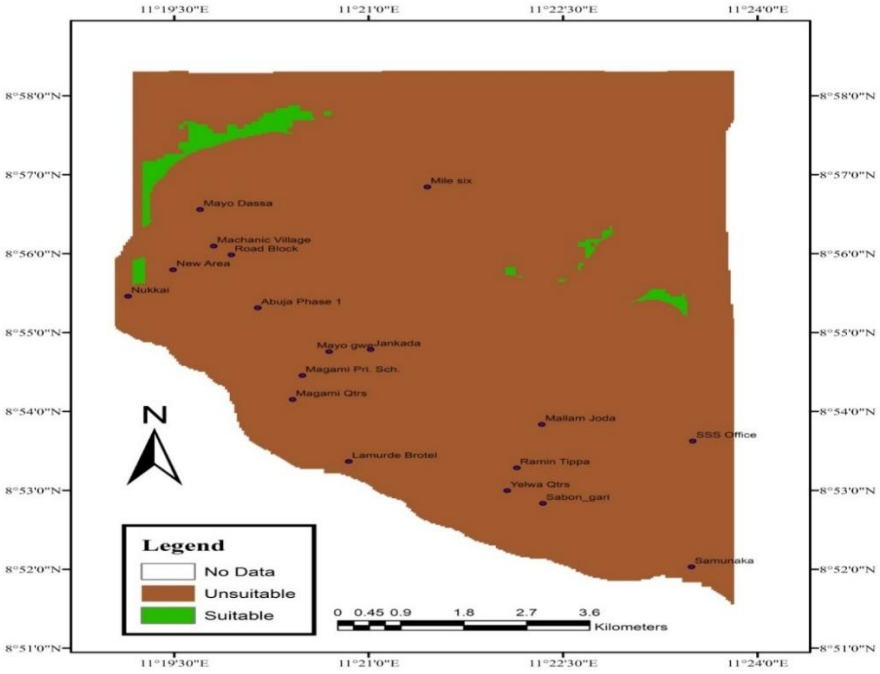

Figure 6: Suitability Verification Map of the study area.

The buffered built-up area map shows that part of the North West, North East and the extreme South East are suitable while more than three-quarter of the study area are unsuitable. The buffered river map shows that about three-quarter of the study area is suitable while the buffered portion of river Mayogwoi which flows North East direction into Lamurde are considered as unsuitable
Figure 3 shows that bulk of the Northern and Southern part of the study area as unsuitable leaving patches of the suitable waste disposal site at the middle and part of the North West.
The Road-Relief map was reclassified and the result in Figure 4 show that bulk of the Northern and Southern part of the study area as unsuitable leaving patches of the suitable waste disposal site at the middle and part of the North West.
The buffered 300m away from major road network which extends from North West to South East was considered as unsuitable while over half of the study area that is North West; North Central; part of North East and South Eastern part are suitable for waste disposal (See fig 4 above)
Furthermore, an overlay operation of reclassified River- Built-up area and Road-Relief map produced suitable area map (fig 5). This result shows that most part of the study area are unsuitable leaving patches of suitable area scantly dispersed in continuous nature at the extreme part of North West and part of North East as shown in figure 5.
Finally, superimposing the acquired coordinates of the sampled existing waste sites on suitable area map (figure 5) revealed that the existing waste sites in Jalingo were all located in unsuitable area as shown in Figure 6. Hence, the need for sitting of new disposal sites in the suitable areas.

CONCLUSION

Site suitability analysis for urban waste disposal in Jalingo metropolis was carried out using Geospatial techniques. This study used integrated standard methodology for the selection of site, which are suitable for the disposal of waste in the study area in conformity with the Samiullahi, 2016; settlement and economic factors like road network; physical factors like topography. However, from the result of the analysis, it was observed that the areas that are "unsuitable" for waste disposal were found around the central business district. While, suitable sites were found to be scantly inhabited relatively lowland areas with few or no water bodies (North West and few areas in the North East part) of the study area.
The study recommended for the establishment of new dump site based on empirical analysis to the State and Local Government Authorities concern to immediately stop waste disposal at the existing dump sites and relocate same to suitable area as the existing dump sites were found to be unsuitable.
This paper will in long run help local planning authorities to select proper disposal sites using modern techniques like GIS/RS.

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APPENDIX I: Existing Dump Sites in Jalingo Metropolis

S/N	Easting	Northing	Location
1	763432	980711	Saminaka
2	762617	981778	Samisnaka
3	760951	982377	Sabon gari
4	760383	982781	Yelwa Quarters
5	760664	982928	Mohammed NYA Primary School
6	759762	983206	Palace House
7	759593	982758	Palace House
8	759056	983093	Lamurde Bridge
9	759326	983120	Karofi
10	758634	983733	Mafindi
11	758678	983716	Mafindi
12	759299	984103	AA Kassa House
13	760522	983526	Angwa Gadi
14	760510	983718	Forest Round about
15	761244	983643	Jekadafari (rami Tippa)
16	761508	983778	Mallam Joda
17	757850	985292	Magami (Quarters)
18	757935	985602	Magami (Primary School)
19	785200	985905	Mayo Gwoi (Bus stop)
20	758766	985962	Jankada
21	757746	987060	Abuja Phase I
22	755619	986997	Nukkai
23	756184	987586	New Era
24	756388	988033	New Area
25	756779	988489	Road Block
26	756441	989682	Mayo Dassa
27	756593	989377	Mayo Dassa
28	756880	988685	Mechanic Village
29	759790	990254	Mile Six (Borrowed Pit)
30	759846	990302	Mile Six (Borrowed pit)
31	763399	983681	SSS Office (Borrowed pit)

Source: Author's fieldwork (2016)

Development of a Geospatial Information Software for Cadastral Survey Data Processing and Management

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Abstract:

Manual approach to cadastral survey data processing is not only rigid, cumbersome, and time consuming but also prone to computational errors. There is need to embrace complete automation of the system for easier, faster and error-free data processing. One of the problems of cadastral surveying in Nigeria is having an appropriate software and tool for processing and managing cadastral data and also for identifying the control stations (with their coordinates) closest to the parcel of land to be surveyed. Attempt has been made in this research to develop a software named Cadastral Survey Office (CSO), designed to successfully identify the closest control point to the land parcel to be surveyed and carry out necessary computations and adjustments for the coordinates of the control stations and the stations defining the boundaries of the land parcel. The software also plots both the client's copy plans and the record copy plans (for lodgement with the regulating government agencies) and as well, provides a digital database for data storage. Statistical experimentation of the developed software shows that there is no significant difference between the accuracy of the coordinates computed using the designed software and the same coordinates obtained from manual computation at 95% confidence interval, with the software showing potentials of greater and more robust accuracy.

Keywords: Cadastral Surveying, Geospatial Information Management, Survey Plan, Fit-for-Purpose, Data processing.

INTRODUCTION

In Nigerian cadastral surveying, having an appropriate tool for processing and manipulating data and effectively managing the record just like in many other fields is a major challenge, that needs to be solved as soon as possible (Asmaa and Heba, 2014). Introduction of geospatial software in different areas of geospatial technology, to a very large extent, has made the processing of data less cumbersome and less stressful. But, carefully studying the cadastral surveying process, it is safe to say that the nature of the cadastral surveying in the country and the high cost of available software have contributed to the lack of open source application of software packages in solving problems. Indeed, most of the imported cadastral surveying software do not completely suit the conventional survey needs and specifications of the country (Anejionu et al., 2014).

Contrary to the current practice in the country where computations of survey data are carried out manually with mere programmable calculators and control details are manually managed in a control booklet, a geospatial database management system that (i) controls the creation, updating, manipulation, querying, storing and accessing of these control details; (ii) carries out the various computations and adjustments to the derived data from the field observation; and (iii) manages the results and final reports, will certainly improve the quality and integrity of the cadastral survey process and facilitate access to the data generated, thereby making the process of control point searching and querying, data processing, presentation and management less cumbersome and time consuming.

Survey software is an essential tool for survey data computation and processing. The processing of the data obtained from the field is very rigorous and time-consuming. When these computations are carried out manually, or semi manually, human errors may jeopardize the accuracy and integrity of the results and the process of correcting these errors can be very time-consuming and computationally intensive (Odumosu *et al*., 2014).

Before carrying out the cadastral field operations, it is a basic surveying principle that all field observations must be connected to a control point (principle of working from whole to part). As a result of this, most surveyors, survey firms and surveying offices usually have a record of all the controls which lie close to the landed properties or parcels of land to be surveyed (Dashe, 1987). But these records are always in manual form (often referred to as control book) and as such, tend to deteriorate with time, leading to the loss of many control details as a result of wear and tear caused by frequent usage. Another problem of much importance is the location and determination of the closest control to the parcel of interest. This can be very hard to find as the Surveyor has to flip through the book page by page and the closest control might not be found to be *in situ* at the end of the day. Also, human errors including omissions and computational errors may be introduced while copying or transferring the details of the control stations. The process of eliminating these errors and also obtaining the corrected coordinates of the traverse stations is a highly rigorous and mathematically intensive process which involves data reduction and adjustment computation (Odumosu *et al*., 2014). Though a couple of computational software are available generally, most of them are not built to meet the specifications of Nigerian cadastral practice which differ from most of those of developed countries as a result of the unique geographical conditions (Anejionu, *et al.*, 2014), while some require the knowledge of basic programming and are quite expensive to purchase.

An example of such computational software is the GeoLab, developed by Microsearch Corp in 1995. Though this software can be used to process various data such as the adjustment of geodetic networks, computation of traverse and reduction of levelling, the license is very expensive, as it ranges between One Thousand Four Hundred and Twenty-Five USDollars ($1425) and One Thousand Nine Hundred And Twenty USDollars ($1920) for a single license (Bitwise Ideas Inc, 2010). Another software for surveying applications is WOLFPACK, which is used for computing latitudes, departures, misclosures and adjustment computations. Though very robust, the software does not have the capability for control data management and automated plan production.

Finally, after the computation of the corrected final coordinates, the coordinates will be used for the plotting and production of the cadastral survey plan which is basically the client's copy and record copy. Currently, there are only two major options available for this plan production. The first is the use of Computer Aided Design (CAD) software, which is quite expensive to procure and is not custom designed to adequately cater for the peculiar needs of cadastral surveying within the Nigerian context. The other option is the manual approach known as draughting. This is not only rigid and time consuming, its management is very expensive (Onuigbo, *et al*., 2015).

This paper presents a geospatial software for cadastral data processing and management. The software provides (i) a control database tool for keeping the records of all the control points in the country; (ii) the reduction and computation of data obtained from field measurements; (iii) the plotting and production of survey plans (both the client's and record copies); and (iv) the creation of a database for keeping all the plans. This paper also highlights the benefits of adopting software packages for cadastral surveying data management in Nigeria.

MATERIALS AND METHODS

The design model (Figure 1) of the developed software is subdivided into five different modules viz: control information management system module, data input and reduction module, traverse computation module, plan presentation module and plan information management system module.

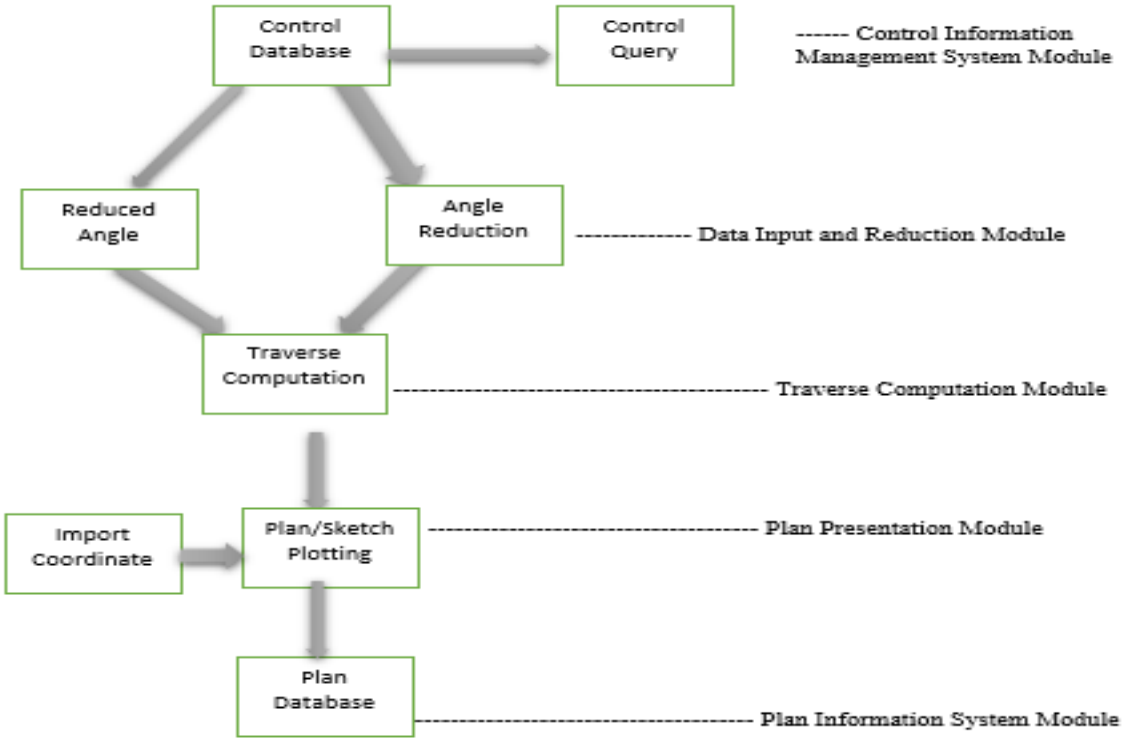


Figure 1: Process flow diagram of the software's implementation

Control information system module

The control information system module of the software handles the management of the control details. Control database keeps the spatial details of all the controls and makes it possible for query and search operations to be carried out on them in near-real time. This can be regarded as an electronic control book or coordinate register to keep the record of the details of all the control stations within the region where the Surveyor is domiciled, and make query and search operations fast and easy. Figure 2 illustrates the framework of the control database from the acquisition of data to production of results (map and report presentation). The control finder provides the closest control to the parcel in a time effective manner by eliminating the time spent on searching through the manual/hardcopy control book. Also, with the electronic database system of the control book, updating can be carried out easily and quickly. The control database query provides the distance and bearing to the closest control based on preliminary station coordinates obtained via a handheld GNSS receiver.

Data input and bearing reduction module

The data input and bearing reduction module provides an interface for the user to input the observed readings obtained from the field. The module enables the software to accept face left and face right readings and then, reduces the angle to mean horizontal angle readings. The module also accepts reduced angles in the event that the angles have been reduced manually or by other software. The data input module also carries out distance correction by using the vertical circle reading. This module relieves the user the stress of having to calculate the reduced angle and the corrected distance manually and by so doing, makes the data processing less cumbersome and less subjected to human error that may occur during angle reduction.

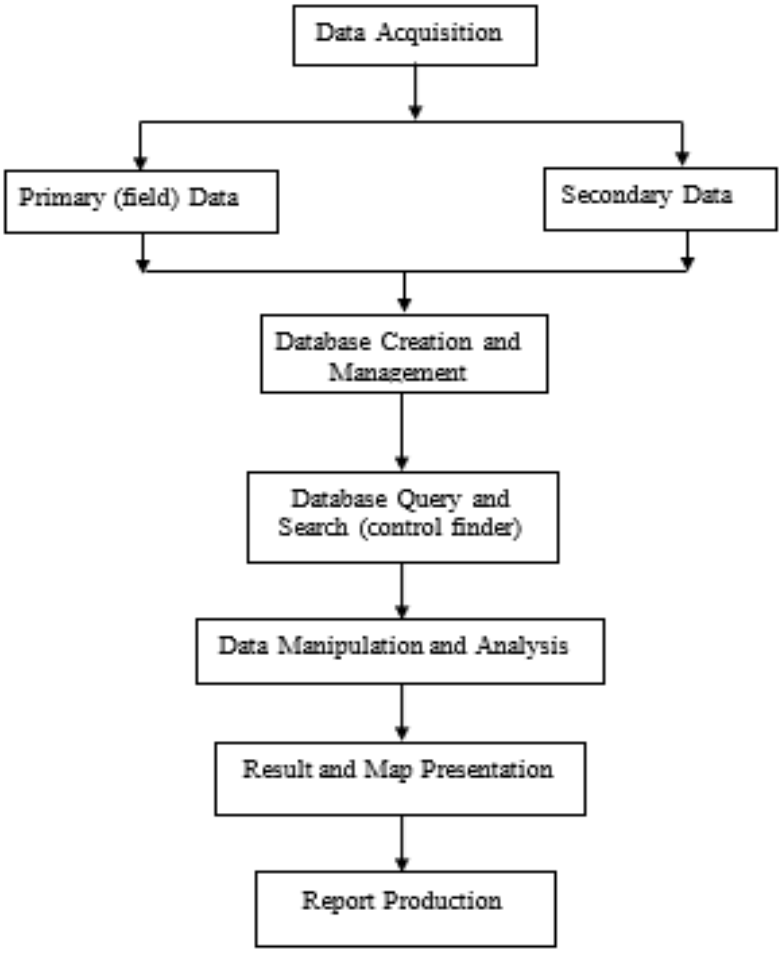


Figure 2: Workflow of the Control Database Creation Methodology

Traverse Computation Module

The traverse computation module handles all necessary computation processes involved in the traversing. It comprises of two parts which are traverse with the unreduced angles and traverse with the reduced angles. When using the unreduced angle, the face left and face right readings observed from the instruments are input, in other words, the raw data gotten from the site are input and the software is left to carry out the reduction of the angle. After this has been done, the controls which are to be connected to the traverse are input or the closest control to the parcel queried with the control finder which is automatically connected to the computation module. The computation module carries out the various computation operations to get the azimuth, change in easting, change in northing, coordinates (easting and northing), corrected coordinates (easting and northing) and area of the parcel. The software uses Bowditch (compass) method of adjustment to carry out the correction and the corrected coordinate of the beacons and stations are gotten.

Plan Presentation Module

The plan presentation module is the module of the cadastral survey office software that is in charge of plotting the plans. The plotter plots the plan of the parcel and the best fit scale is selected from the list of scales available. The plotter plots directly with the coordinates generated by the computational module or the coordinates input by the user. Other details such as beacon name can

be input into the software. Figure 3 shows the print screen of the plotter, which is the component of the plan presentation module.

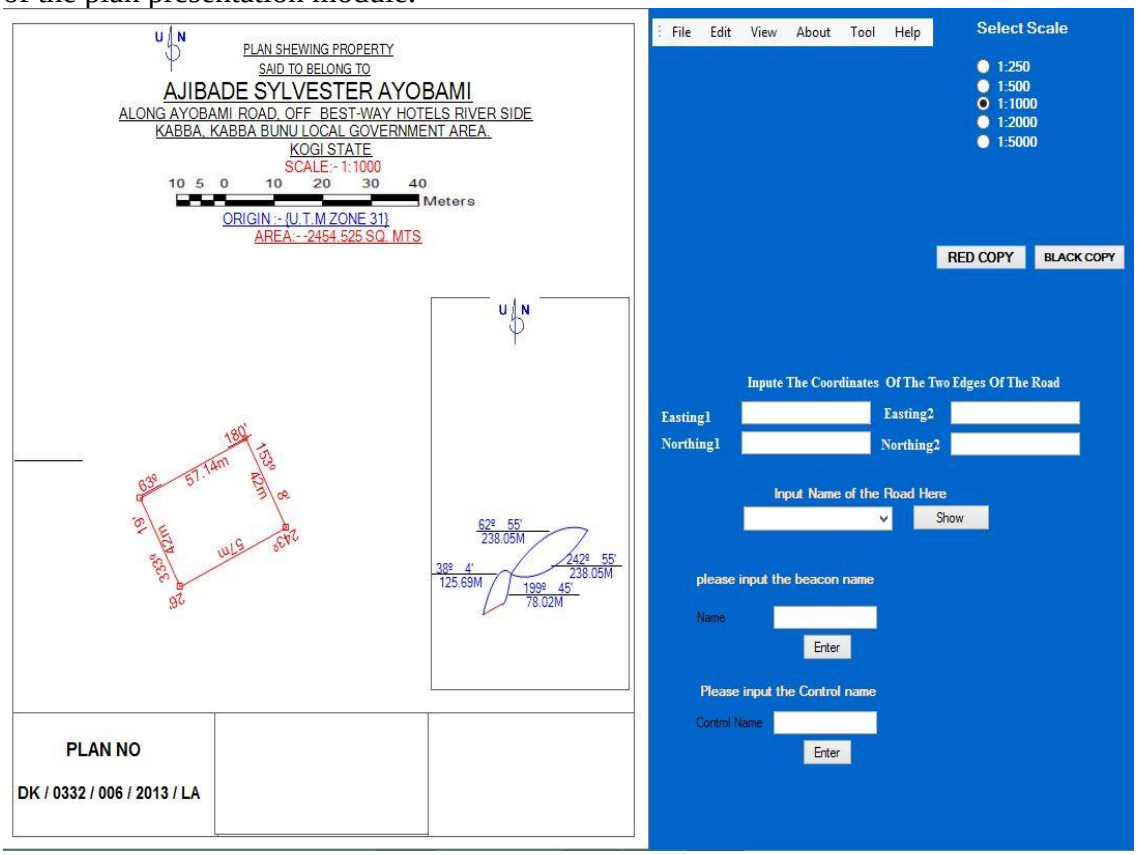


Figure 3: Print Screen of the Plotter Module of the Cadastral Information Software

Plan Information System Module

Plan information system module serves as the geodatabase or e-store, where all the details of the produced survey plans are safely kept. In any given firm's database, all completed cadastral survey jobs can be stored for future use. It is an alternative approach to the manual method of storing survey plans and records for future use. This makes querying very easy as plans can be easily searched using their plan number or client's ID. The problems of the plans deteriorating with time and the problem of having to spend time looking for a particular record can be eliminated with the use of the software. The designed software is codenamed Cadastral Survey Office (CSO). It is a standalone software that uses Structural Query Language for database management.

RESULTS AND DISCUSSION

The cadastral survey office software was experimented using the readings obtained from a field observation. The software was tested based on its computation accuracy and the plotting of the traverse sketches and plans. Table 1 shows the difference in coordinates between those computed with the software and those computed manually (by simple excel codes) using Bowditch method of traverse computation.

From Table 1, it can be observed that the final result (coordinates) obtained from the cadastral survey office (CSO) software and the manually computed coordinates are almost the same signifying sub-millimetre level of consistency between both computation approaches.

The Student-*t* distribution test was also carried out to determine the confidence interval of computed Northings and Eastings. The choice of Student-*t* distribution statistical model was informed by the size of the sample data or population (Number of traverse stations) which is less than 30. Result of the statistical analysis is presented in Table 2.

Table 1: Coordinate difference between the Cadastral Survey Office Software and Manual computation results

	COMPUTED DISCREPANCY	
S/N	**Difference (mE)**	**Difference (mN)**
1	0.0004	0.0004
2	0.0004	0.0004
3	0.0005	0.0003
4	-0.0004	-0.0003
5	0.0003	-0.0004
6	0.0001	-0.0002
7	0.0002	-0.0002
8	0.0000	-0.0005
9	-0.0001	0.0002
10	-0.0001	0.0003
11	-0.0001	0.0001
12	0.0000	0.0000
13	0.0000	-0.0003
SUM	0.0012	-0.0002

Table 2: Paired Samples Test

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Software - Manual	-0.00004	0.00029	0.00006	-0.0002	0.00008	-0.68	25	0.503

From Table 2, it can be observed that the correlation between the result obtained from the software and the result gotten manually is +1 and the significant (sig) value is 0.000. This implies that the mean of the coordinate produced are highly (100%) and positively correlated. Also, the mean error of -0.00004 and the *t* value of – 0.680 which is less than the sig value of 0.503 indicates that the software is accurate at 95% confidence. The software was further tested using several data that involves more traverse stations, and the result gotten shows that the software is accurate at 95% confidence interval and fit for all order of accuracy.

Control Database and Query

The control database of the software was double checked to ensure that the controls input was correct. Also, the software was further tested to ensure that the closest control ID to the input coordinates are identified automatically by the software based on the coordinates of the control stations already fed into the software's database. To carry out this, several parcels were visited and coordinates of points input into the software and the closest controls given were confirmed. The software also makes it possible to access, edit, input and remove control records in case there is a

modification or loss of control. Figure 4 shows the print screen of the control database updating box and the data grid of the database.

Plotter

The plotter was tested by comparing the survey plan produced with the aid of the software to the survey plan produced with the aid of AUTOCAD. Figure 5 shows the survey plan of the land parcel produced using AUTOCAD and Figures 6 (a & b) show the survey plan of the same land parcel produced with the software. Visual expression of both plans shows that there is no significant difference or disparity between them. The only difference is that the process involved in the plan produced with the software is completely automated while the AUTOCAD produced survey plan requires more human inputs and assistance. These further attests to the suitability of the designed software for cadastral plan production.

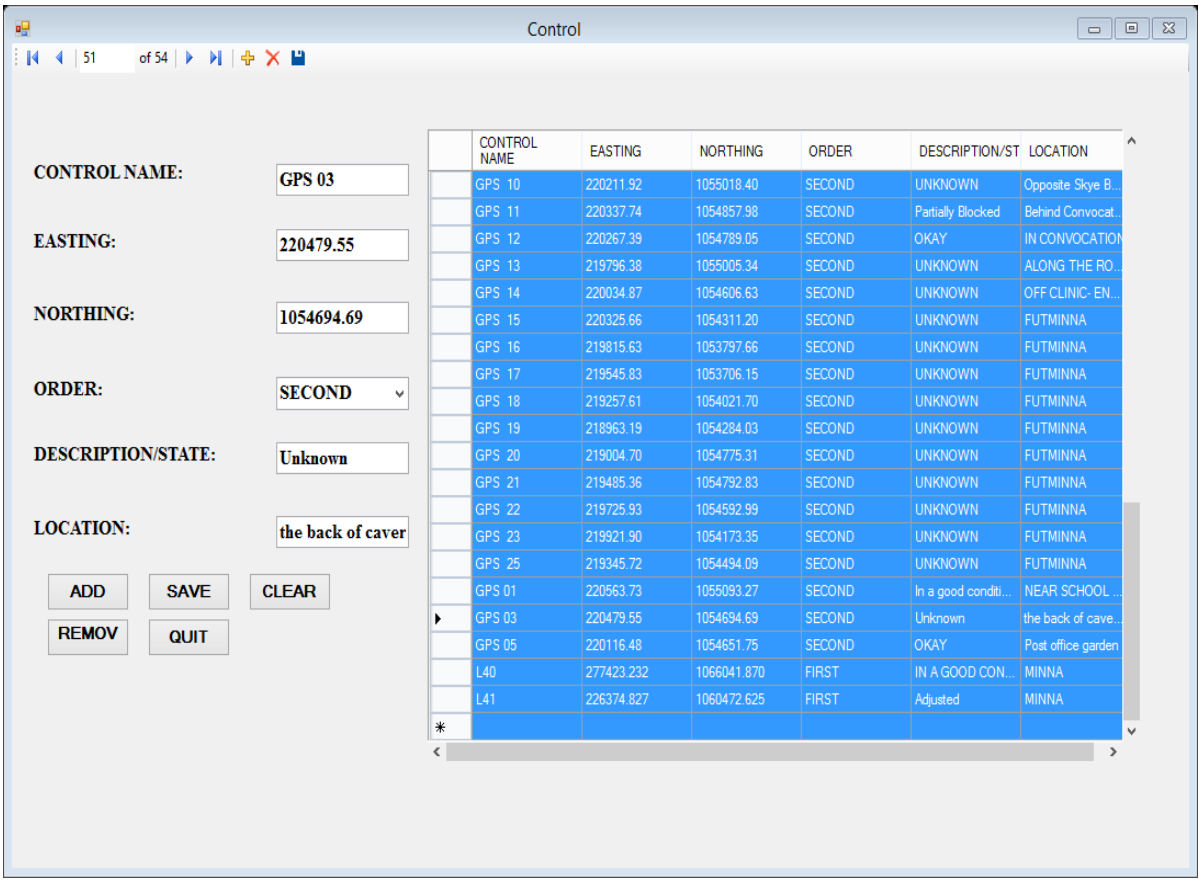


Figure 4: Print screen of database of Controls

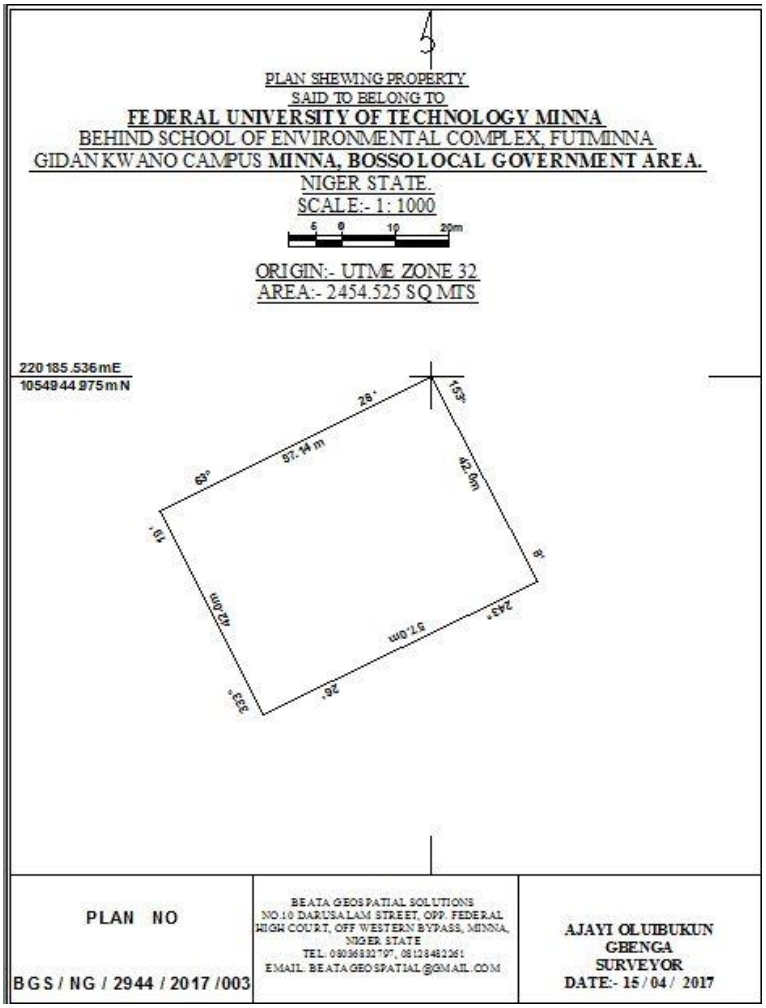
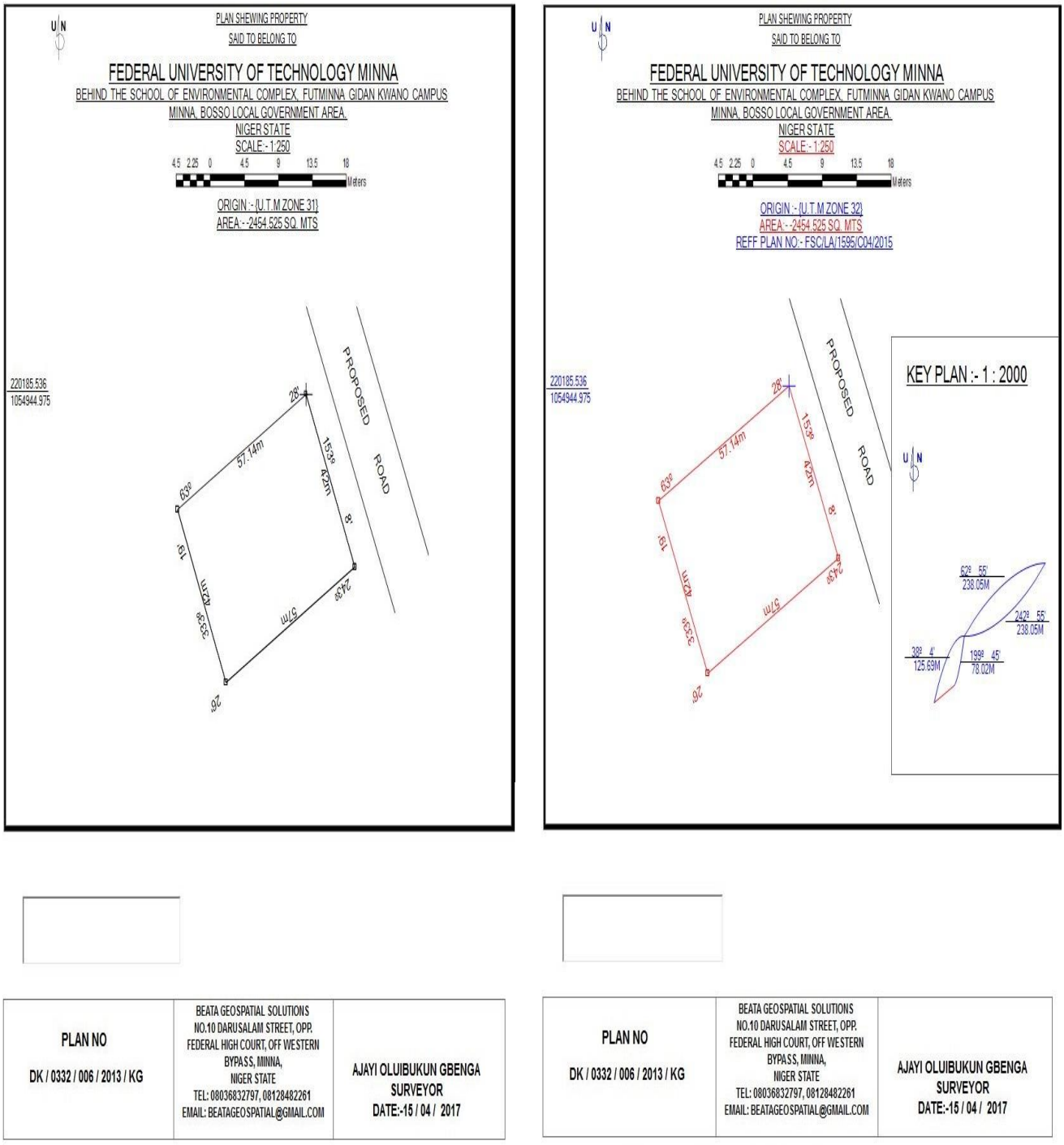


Figure 5: Plan produced with AutoCAD



(a) (b)

Figure 6: (a) Client's copy plan produced using the Cadastral survey office software (b) Record copy plan produced using the Cadastral survey office software

CONCLUSION

The gap between the measurement of field data on site and the presentation of plans to the client can be bridged by using the cadastral survey office software. The software is equipped with a

control database which allows users to store details (spatial and non-spatial) of existing control points within their area of interest. It also contains a tool named control finder which allows users to search for control stations closest to the parcel of land to be surveyed using the control database. The software reduces angles, and computes corrected coordinates of traverse stations. It also cartographically plots the survey sketches and plans of the parcels, and provides a database for managing the produced survey plans.

All the formulae employed for the development of the software are the general conventional models used in traverse computations. Experimental results obtained from the software showed that there is no statistical difference between the accuracy obtained from the coordinates generated using the software and through conventional means. The survey plans produced using the software also favourably competes with the survey plans produced using conventional Computer Aided Design (CAD) software such as AutoCAD which makes it reliable and safe for usage.

The designed software will not only provide optimum data processing and result presentation that suits the traditional cadastral surveying practice in the country, it will also reduce tremendously, the huge sums of money being expended by Nigerian Surveyors to purchase licenses of foreign developed data management and plan production software. The user-friendly nature of the software which requires no knowledge of computer programming will encourage more surveyors to adopt the usage of automated systems in their data processing and survey plan production, which will ultimately lead to the advancement of surveying profession in Nigeria.

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Application of Location Based Service for flood Vulnerability Assessment of Part of Minna, Niger State, Nigeria

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Abstract
Flood disaster has been a global emergency issue, the cause may be traced to both natural and man-influenced factors, the alarming increase in global warming has an underlying effect on glacial melting, sea level rise etc. these, coupled with the effect of human activities such construction along flood plain, deposit of waste in rivers etc. have pose a threat not only lives but putting properties into danger. In order to alleviate the effect of this flooding, emergency agencies and individual must be informed about the status of such emergency. Flood vulnerability status is thus a reliable solution to such problem. How will individual get current vulnerability status of their current location? The research revolves around creation of an android application capable of indicating the vulnerability to flooding of points within the study area. Data source include administrative map, Digital Elevation Model and Landsat Imagery with band 6, 7 and 8. ArcGIS software was used to produce the flood vulnerability information and database for the study area. Different elevation ranges; (very low, low, moderate, high and very high) were classified to determine the flood vulnerability status. The android application was developed using Android studio application. The location based service in the mobile device help to correlate the longitude and latitude information of points within the study area with the database to determine the vulnerability status of an area to flooding on average scale. It also stores such details. The result shows that the study area is a relatively low terrain and is more vulnerable to flooding; with very low and low terrain having a percentage of 18 and 36% respectively. The result also show that only 11% of the study area are built up with vegetation and farmland having a percentage of 18% and 22% respectively. Although it was discovered that the flood vulnerability assessment can only be done within the study area, updating can be done to enable it work for other area.

Keywords: *Android application, Location based service, flood vulnerability, landuse/land cover and Digital Elevation Model (DEM)*

1.0 INTRODUCTION

Apart from the 1936 flood disaster in Nigeria, Aliyu (2018) identified certain flood disaster which include; the disaster that ravage Ibadan (1985, 1987, 1990), Oshogbo (1992, 1996 and 2002), Yobe (2000), Akure (1996, 2000, 2002, 2004, and 2006), Abia Adamawa and Akwa Ibom in 2001, coastal cities such as Lagos, Port Harcourt, Calabar and Warri experience annual flooding during raining season. Cases of collapse of buildings and flood incidents have been in occurrence over the past few years and even this year within the study area (Aliyu Bashar, 2018). This incidence has posed a threat to lives and properties of which these people and properties are located in areas with high flood vulnerability and as such a need for an easy to understand and easy to use source of vulnerability information of an area to flooding.

Location based services (LBS) can be defined as computer applications (especially mobile computing applications) that deliver information tailored to the location and context of the device and the user (Raper *et al.,* 2015). Recent years have witnessed rapid advances in its enabling technology, such as mobile devices and telecommunication (Burak and Sharon, 2015). Secondly, there has been an increasing demand in expanding location-based services (LBS) from outdoors to indoors, and from navigation systems and mobile guides to more diverse applications (e.g. healthcare, transportation, and gaming) (Raper *et al.,* 2015). Thirdly, new interface technologies (e.g. more powerful smartphones, smart watches, digital glasses, and augmented reality (AR) devices) have emerged. Moreso, there has been an increasing smartness of our environments and cities (e.g. with different kinds of sensors) (Ratti and Claudel, 2016). Finally, more and more

location based services (LBS) are entering into the general public's daily lives, which greatly influence how people interact with each other and their behaviors in different environments
The first location based services (LBS) appeared in the early 1990s (e.g. active badge), location based service (LBS) became a fast-developing research field only in the early 2000s, mainly due to the discontinuation of the selective availability. Selective availability was an intentional degradation of public Global Positioning System (GPS) signals implemented by the U.S. Government for national security reasons. View all notes of Global Positioning System (GPS) by the U.S. President Bill Clinton in May 2000. This discontinuation has made GPS more responsive to civil and commercial users worldwide (Ladan, 2016). Since that time, more and more GPS-based applications have appeared, resulting in a strong interest in location based services (LBS) from both academics and industry. This has paved way for geospatial approach in general emergency management and control. Andi et al.(2017) use geospatial approach for flood vulnerability mapping, Ladan (2016) show that Satellite Remote Sensing can be applied in Terrain Analysis and Flood Plain Delineation, this can also be seen in other research that have identified flood, landslide and seismic effect as a tool for hazard assessment (Bathrello *et al.,* 2016), for flood assessment (Ouma and Tateishi, 2014; Andi *et al.,* 2017) incorporate Analytical Hierarchy Proces(AHP) and GIS to predict flood vulnerability using rainfall, elevation, drainage , land , soil and slope as parameter, Siddayao *et al.,* (2014) use population density and distance from river bank as parameters, while Kazakis et al. (2015) evaluate flood hazard by adding flow accumulation, distance from channel stream and totally covered stream and hydro-lithological formation. Klein (2014) Develop a method which uses android application to address the vulnerability to climate change and climate. The ability of an android device to detect small or large variations in height details of an environment as they affect flood vulnerability of such an environment is of paramount essence and not commonly available to the general public. Although maps were generated from their various researches, much effort has not been put in place to automate such result and create a spatio-temporal vulnerability map which will be made readily available to individuals during on-site decision making. Recent flooding in the study area and the need to procure a lasting solution has also geared this research work as many buildings and structure experience collapse since no prior assessment was done before engaging in construction and development. Klein (2014) stated that flood vulnerability information is a very vital information in engineering and construction operations.
The study deal with the determination of flood hazard status of specific positions in an area, using a smart approach which is through the use of android application. The objective is to identify flood hazard zone, by creating a database for flood risk area, and also developing an android application which will enable decision and policy makers to have a first-hand information of the vulnerability status of specified location on their mobile devices. The parameters used for flood vulnerability were landuse/landcover map, slope and elevation data.

2.0 STUDY AREA

The study area is an area of 10km buffer zone around Federal University of Technology Minna, Gidan Kwano Campus, Niger State. Niger State is a state in Central Nigeria and the largest state in the country. The state capital is Minna. Minna is a city in Middle Belt Nigeria, located between latitude 9° 36′ 50″ N and longitude 6° 33′ 25″ E and it is situated at elevation 243 meters above sea level.. It consists of two major ethnic groups: The Nupe and the Gbagyi.. Its headquarters are in the town of Maikunkele. It has an area of 1,592 km² (The Concice Britannica, 2019). Some of

the socioeconomic activities carried out within the research area include black smiting, weaving, pottery and furniture making. The research area is within Bosso local government Area, Minna Niger State. The study area varies between latitude 9°50' N-9°20' N and longitude 6°10'E-6°40'E. Figure 1.0 shows the map of the research area.

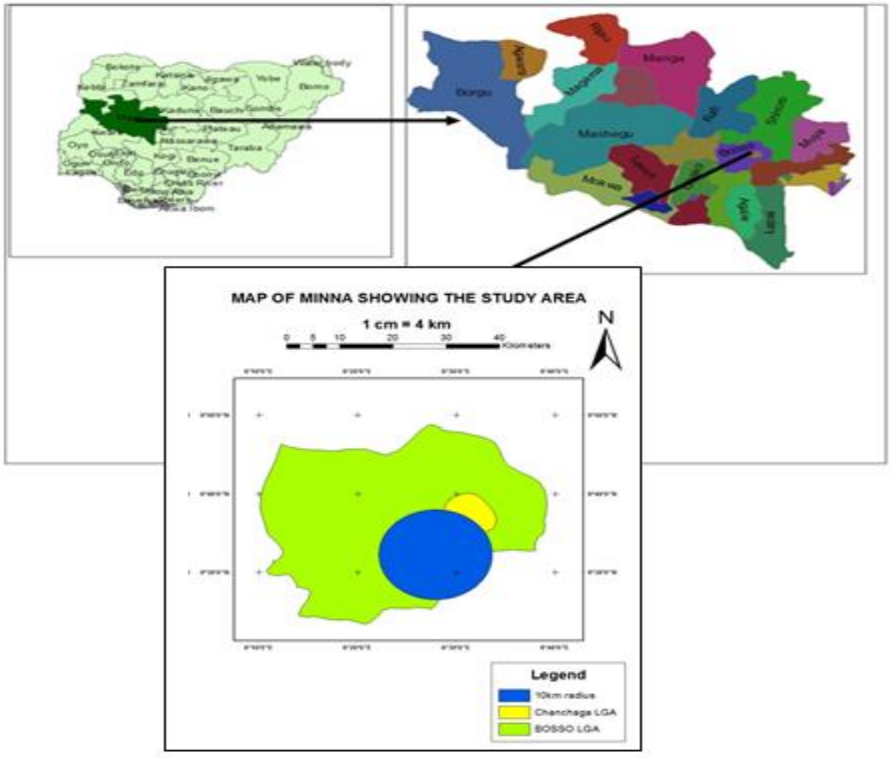

Figure 1.0: Map of study area

3.0 Materials and methods

Vulnerability maps can be utilized in all steps of disaster management; prevention, mitigation, preparedness, operation, relief, recovery and lesson learnt (Andi *et al.*, 2017). The risk faced in the recent years have cause various kind of losses. In order to build sustainable cities and environment, individual must have first-hand information of the vulnerability status of their environment. The overall description of method for application of location based service for flood vulnerability assessment is explained in figure 3.0, Landuse/Landcover map was generated from the Landsat imagery using Maximum Likelihood classification, Arithmetic overlay was done between the DE M and Landuse/Landcover map to generate the Flood Risk Map, using raster calculator. The map generated was thus incorporated with the developed android application, using the local scale formulated by (Fekete *et al.,* 2010), the vulnerability scale of an area can be determined through the application and its status reported.

3.1 Data source and acquisition

The data source can be categorized into primary and secondary data source, Primary data include the coordinates of controls within the study area, the UTM coordinates of these controls were collected from the department of Surveying and Geo-informatics, Federal University of Technology Minna, Niger State and are shown in the table 3.0, they were used for Geo-referencing.

Table 3.0 Control Points and their coordinates

CONTROL POINTS	LATITUDE	LONGITUDE
GPS 01	9.535576	6.454623
FUTSVG 01	9.529549	6.465483
CSN 128P	9.549321	6.473994

Secondary data source include; Administrative map of Minna obtained from the department of Geography, Federal University of Technology Minna, Digital Elevation Model SRTM 1 arc seconds downloaded from United State Geological Survey (USGS), shapefiles, satellite imageries

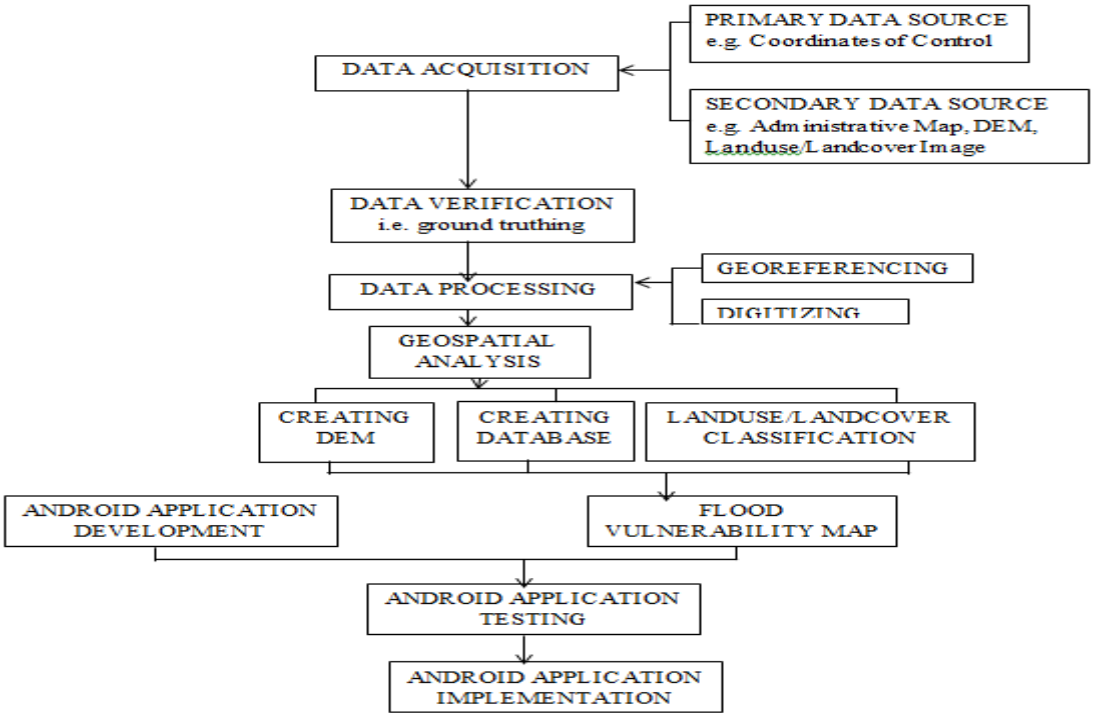

Figure 3.0: The methodology flow chart for the research

3.2 Data processing

The data processing can be broadly grouped into three stages, which include; generating the DEM of the study area, generating the Land use/land cover and finally incorporating the two map together to generate the Flood vulnerability map. The extracted DEM image of the study area was processed and filled, using the 'Symbology' feature in the ArcGIS, the different height ranges from very low areas to very high areas were obtained and the necessary color convention was given to show these range of height differences.

3.2.1 DEM and landuse/landcover analysis

The shape file for the administrative boundary of Minna from which the DEM image, Land cover/land use images for Minna metropolis were selected and extracted. With reference to Google earth for better accuracy, the training sites of the features within the study areas were selected and a Maximum likelihood classification was carried out on the composite image of the Land use/land cover bands.

To depict areas vulnerable to flood activities more efficiently an overlay process is required. This overlay was done using the principle of the "Arithmetic overlay" process, which involves raster addition. Using the "Raster calculator" tool in the ArcGIS the Land use and Land cover image was added to the DEM image of the area to give a new flood risk map of the area, via a simple arithmetic operation, that is:

Land use Land cover image + DEM image = Flood Risk map/overlay map

From the attribute Table (Table 3.1) of the risk regions of the study area, the area of each region of height differences was calculated and the percentage covered by each region determined. To obtain the coordinates covered by each region, the risk map was converted to point feature, to give the latitude, longitude and elevations of points within the regions of each height difference. These coordinates serve as database for the android application building. Conversion of areas of different elevation data details to Shapefiles, such shapefile polygon features were then converted to point files, generating the latitude, longitude and elevation of such points and adding to the database for each class of low, high and moderate elevations, as classified using the ArcGIS software for range of elevations.

3.2.2 Elevation Scaling

Fekete *et al.* (2010) identify two main scale used in flood vulnerability assessment, which include sub-national and local scale, the specification for local scale was used as shown in Table 3.1, as the radius of study area is 10km.

Table 3.1 Attribute table of vulnerable regions (Fekete, 2010)

Class	Elevation Range(m)	Number of points
Very low	157.000-215.000	63,222
Low	216.000-237.000	132,533
Moderate	238.000-262.000	100,981
High	263.000-298.000	42,096
Very High	299.000-404.000	26,192

The application was built using Android studio software with Java programming language, the location-based service on android allows the determination of location of a point which is turn incorporated with the flood risk database. The application thus provides two specific information which include; the location of user and the flood vulnerability status of such location.

3.3 Image processing

The study adopted the concept of Geo-referencing and digitizing

The internal coordinate system of a map or aerial photo image was related to a ground system of geographic coordinates (USGS, 2019). The ground coordinates in UTM Northings and Eastings were converted to latitudes and longitudes (in decimal degrees), and used to geo-reference the satellite imagery. The ground coordinates were entered into Excel and the coordinates of the control point and were imported into the ArcGIS environment. Certain features which include boundaries of local government areas within Niger State, buildings, water features and vegetation areas were vectorized from the acquired raster imagery into point, line and polygon features.

3.4 Data analysis

Database management is discussed in this Section

A database is an organized collection of data, generally stored and accessed electronically from a computer system (*Beynon-Davies, 2017*). It can be updated and scope of coverage increased over time, as this will continue to assist in the process of querying for any desired information from the set of data under the database. In creation of the database for the application, the latitudes, longitudes and elevation of points over the 10km radius were the most crucial and required information, these sets of information were grouped into separate files within the database in the order of: database for very low elevation points, database for low elevation points, database for moderate elevation points, database for high elevation points, database for very high elevation points (figure 3.0). By correlating these information in the database with the information from the mobile device (latitude and longitude) the application is capable of ascertaining to which class of data such points belong. Figure 3.0 shows the flow chart used for the data analysis.

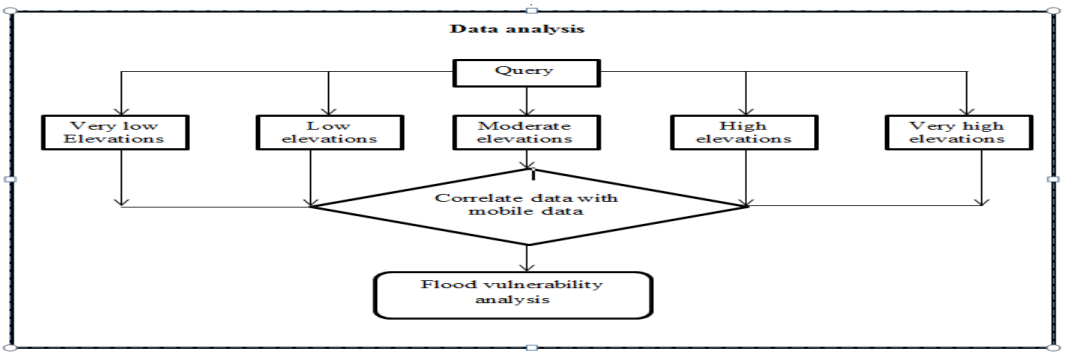

Figure 3.0: Flow chart for the data analysis

3.5 Application operation

The application simply operates and displays data by reading the information provided by location service of the android device and correlating it with the data in the database. It matches the longitude and the latitude from the device with the longitude and latitude of the database and uses this information to ascertain which class of elevation this information falls, after ascertaining that, it displays the elevation information and tells if the elevation is low, moderate or high. Using this information, it tells the user if the area is vulnerable or not.

4.0 RESULTS AND DISCUSSION

This section analyses and displays the result obtained from the study, by depicting information's on achievement made at various stages.

4.1 Classification of features

The landuse/landcover satellite image of the study area was used in the carrying out a supervised, maximum likelihood classification of features within the study area, using the ArcGIS software. The various landuses and land covers within the study area were depicted and the percentage covered by each landuse computed and displayed (Figure 4.1). The classification process comprises of the composite image of bands 6, 7 and 8 of Landsat image of the area and the result of the various features displayed using different color conventions (Figure 4.4).

4.2 Elevation analysis using the digital elevation model (DEM) of the study area

The SRTM DEM of the study was used in the elevation analyses and categorization of the range of elevations used in ascertaining points of low elevation, which are usually prone to flood activities and points of high elevation which are usually less prone to flood activities (Figure 4.2). It can be seen from the map in Figure 4.2 that the maximum elevation of point within the study area at this stage is 390m, and the lowest elevation point is 156m. This information prior to the overlay with the landuse/landcover shows the elevation characteristics of the bare earth surface.

4.3 Overlay analysis

In order to depict and acquire the elevation properties of the earth surface as it stands in the real world, an overlay operation comprising of the Arithmetic overlay of the SRTM digital elevation model and the landuse/landcover satellite image was carried out using the arithmetic overlay model (Figure 4.3). The maximum elevation point in the resulting raster image is 404m and the lowest elevation point is 157m as seen in Figure 4.3. The increase in elevation (Figure 4.3) after overlay indicates the presence of features both natural and artificial been overlaid on the initial DEM (Figure 4.2) of the area.

Elevation Classification is as discussed below:

Using the "Symbology" feature in the ArcGIS environment, the area was divided into five classes of elevations as shown in Table 4.1. The lower the elevation of points within an area, the higher the level of vulnerability of such area to flooding. From the elevation details of the various raster classes, the regions more susceptible to flood action are regions of very low elevation points and regions of low elevation points with a combined percentage area of about 57%, which is more than half of the study area (Table 4.1). Regions of moderate elevations are less liable to flooding except in situations of heavy rainfall and poor drainage within such regions. Regions of high and very high elevations are safer zones with less probability of flood actions, occupying a combined percentage of about 18% of the study area (Table 4.1). This shows that not up to a quarter of the study area are less vulnerable to flood actions. Based on this information of the elevation details the vulnerability assessment of the study area was carried out.

Various color conventions for the ranges of elevations after overlaying the SRTM DEM of the area with the landuse/land cover image of the area are used to show the different elevation classes (Figure 4.4). It can be seen that there is a potential increase in the elevations of points of low, moderate, and high elevations and a decrease in the elevations of points of very low and very high elevations (Table 4.1) before and after overlay.

Table 4.1: Table of the percentage and elevation values of the various elevation classes

ELEVATON CLASS	% BEFORE OVERLAY	% AFTER OVERLAY	ELEVATION VALUE AFTER OVERLAY
VERY LOW	22.28486176	19.09764628	157.000000-215.000000
LOW	32.89719578	37.01185584	216.000000-237.000000
MODERATE	25.6824721	26.13062629	238.000000-262.000000
HIGH	9.567735178	10.84955671	263.000000-298.000000
VERY HIGH	9.567735178	6.910314876	299.000000-404.000000

4.4 Database creation

In order to create a group of points within the various elevation classes, each class of elevation were converted to polygon feature and then subsequently each polygon feature of the various class of elevation converted to group of point features with each point comprising of the latitude and

longitude information of the point. Points with the lowest of elevations were masked out of the overlay map and a polygon shape file of the raster class created to enable conversion of the class to a point shape file (Figure 4.5). This enables the coordinate characteristics and the elevation details of points within the raster class represented to be obtained and stored in the database used by the application. This process was repeated subsequently for elevation classes of low (Figure 4.6), moderate (Figure 4.7), high (Figure 4.8) and very high elevations (Figure 4.9).

The database created consist of the longitudes, latitudes and elevations of points within the study area (Table 4.2), these data sums up to tens of thousands of generated points, of which the application correlates the real time coordinates of points with the points on the database to ascertain which class of vulnerability the elevation using its coordinate value falls in. The dataset (Table 4.2) were added to the raw folder of the project structure, after converting the Excel file to JSON (Java Script Object Notation). JSON uses human readable text to transmit data objects consisting of attributes-value pairs and array data types or any other serializable value (Doug, 2019).

Table 4.2 Sample data used in creating the database for the application

	Longitude		Latitude		Elevations
	6.468622		9.441785		186
	6.452681		9.443929		186
	6.44358		9.443863		186
	6.459522		9.44172		197
	6.457247		9.441703		213

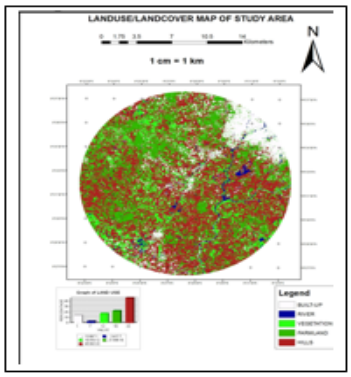

Figure 4.1: Map of the LULC of the study

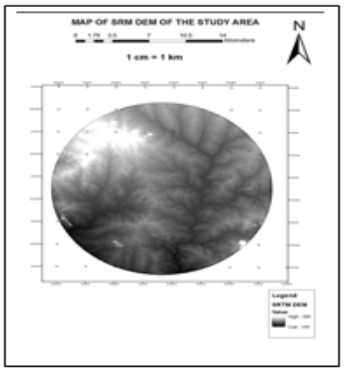

Figure 4.2: Map of SRTM DEM of the study

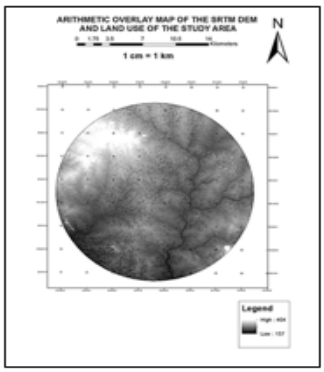

Figure 4.3: Overlay map of the SRTM DEM and LULC image of the study area

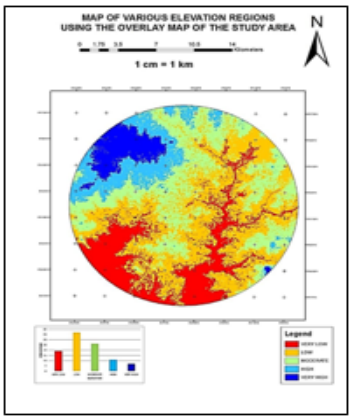

Figure 4.4: Map of the various elevation differences after overlay of the study area

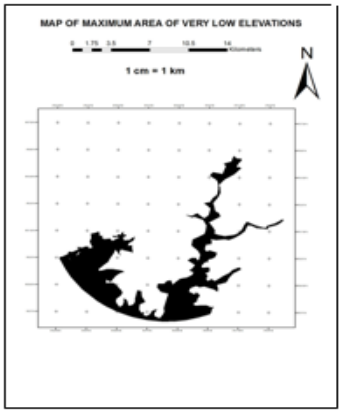

Figure 4.5: Map of maximum areas of very low elevation used for database creation.

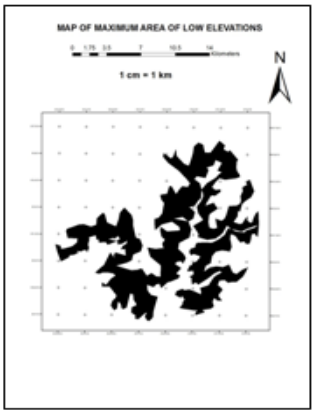

Figure 4.6 Map of maximum areas of low elevation used for database creation

4.5 Display result

The android application with the aid of the location based service reads in the latitude and longitude information of the position occupied by the mobile device and then searches for the class of elevation within the database to which this positional information belongs and then displays the vulnerability information on a point-based system. Using this information, result of multiple points within an area can be derived, and if in a land parcel more than 70% of the boundary points falls within the first two categories of elevation as shown in Table 4.3. It is safe to say such an area is highly vulnerable to flood activities; using this principle the vulnerability of any area can be identified. Although this is not the most accurate means of depicting flood vulnerability information but is adequate to guide variety of users in identifying the vulnerability of an area to flooding.

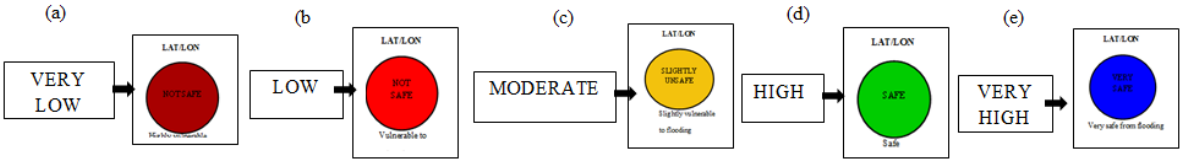

Figure 4.6b: The various categories of elevation in application display

4.6 Operational information

The operational information about the application is shown in figure 4.0

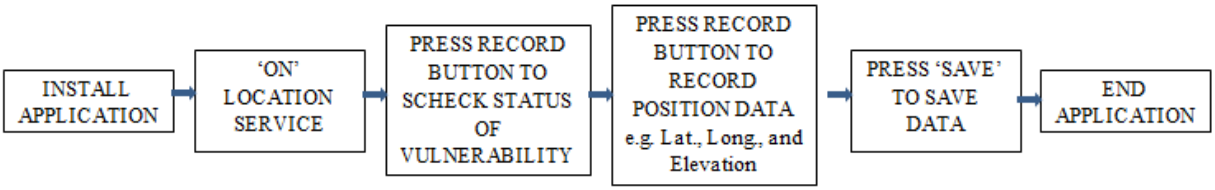

Figure 4.0 Operational information of the app

You can access the saved file from your File manager on your mobile device memory. When the application is operated outside the 10km radius of the study area, it displays 'NO DATA' (Figure 4.11), with additional information below the display panels.

4.7 Application validation/updating

The application can be validated and updated with a new database added to the JavaScript of either of the same area or of another area. It should be noted that as the volume of data increase in the database, this will result to a slower operation of the application and lagging in some android devices with lower memory space. To solve this problem an online database can be created and a program added to the program script of the app to enable the app access this online resource/database, more also another database format like MySQL can be used in the database management. The need for an external management source of the database is to enable a faster operation of the application. The interface can be updated and edited via coding of the app script.

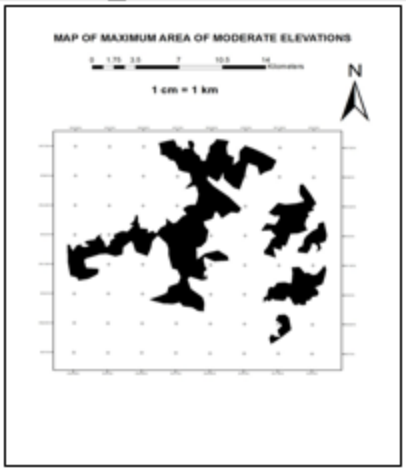

Figure 4.7: Map of maximum areas of moderate elevation used for database

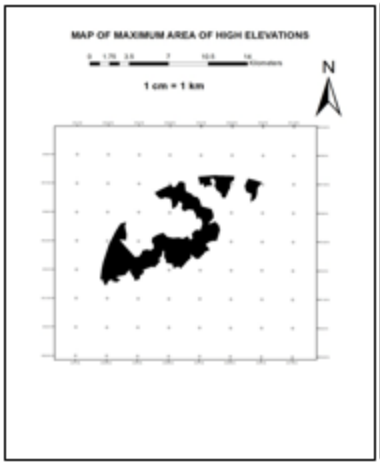

Figure 4.8: Map of maximum areas of high elevation used for database

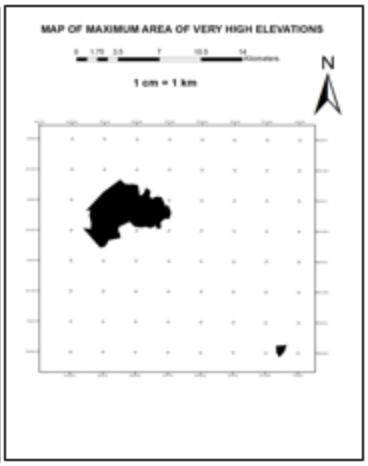

Figure 4.9: Map of maximum areas of very high elevation used for database

Figure 4.11: Display information of the application outside study area

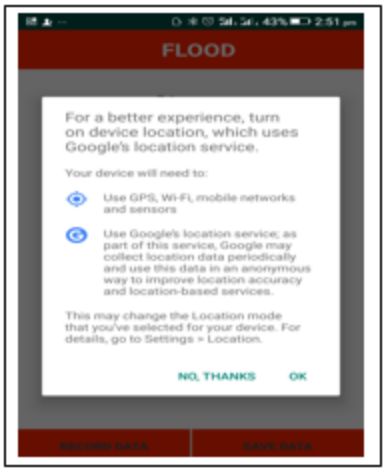

Figure 4.12: The pop up information for location service of the device

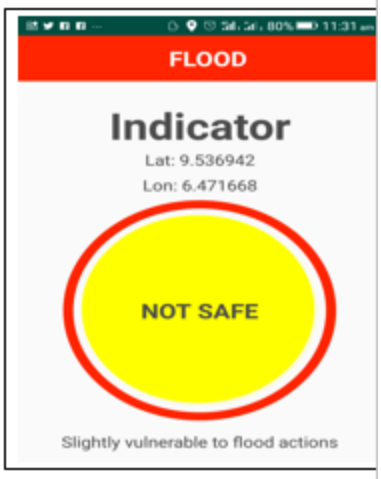

Figure 4.13: The vulnerability information to flooding at a position

5.0 Conclusion and Recommendation

We can only minimize the impact of flooding as a natural disaster we cannot totally remove it. Assessing the vulnerability is not just enough as information is only limited to researcher and archives of such field of learning. The study opines to assess and incorporate such assessment into an android application to make it readily available to anyone as a form of first-hand information to know the vulnerability status of their current location. The assessment shows that the study area is a relatively low terrain and is more vulnerable to flooding; with 'very low' and 'low' terrain having a percentage of 18 and 36% respectively, while moderate, high and very high has 26, 12 and 8% respectively. The result also show that only 11% of the study area are built up with vegetation and farmland having a percentage of 18% and 22% respectively, hills and rivers have a percentage of 45 and 4% respectively. The result also indicated that while the application was tested, it worked perfectly for points within the physical cope of the study area, but had a limitation outside the scope. Updating, validating and enlarging the physical scope of the work more than

our study area will be suggested for further research. The Analytical Hierarchy Process (AHP) procedure used by (Andi *et al.*, 2017) can be implemented to help GIS and Remote Sensing preserve up-to-date information at low cost and good visualization.

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Flood Inundation Mapping of Gbaganu Area Minna, Niger State

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Abstract
Flooding in recent times has become a critically problematic phenomenon of spatio-temporal order and considerably high frequency of occurrence all over the world. Gbeganu area of Minna covering an area of 16.389hectares within Niger state, Nigeria has witnessed and is still witnessing multivariate cases of flooding which attains its peak in the rainy seasons (April-October) of every year, sometimes resulting to loss of life and economic valuables/properties. In order to curb this menace, an integrated solution of drainage morphometric parameters with remote sensing and geographical information system capacity is thus herein presented using the downloaded Shuttle Radar Topography Mission (SRTM) of 1-arc second (30m resolution) which covers nearly the entire Niger State and the DEM of the study area was extracted and digital elevation model (DEM) generated from topographical point data (position and elevation of points within the area) taken with Differential Global Positioning System receivers and the satellite image of the study area to delineate watershed, contributing area, flow direction and flow path/channel. The Height Above the Nearest Drainage (HAND) tool was used on ArcGIS software for analyses. The study was able to produce a map depicting within the study area; regions that are highly susceptible to flood. The morphometric analysis of flood inundation hazard in the area watershed shows that the risk to building will be more serious in the nearest future meanwhile the implementation of flood countermeasures and the identification of priority areas for flood risk reduction using flood inundation map will also help to reduce the flood impacts within the study area.

Keywords: *Flood inundation mapping, digital elevation model, remote sensing, geographical information system and height above the nearest drainage*

INTRODUCTION
Floods can be explained as excess flows exceeding the transporting capacity of river channel, lakes, ponds, reservoirs, drainage system, dam and any other water bodies, whereby water inundates outside water bodies areas (Getahun and Gebre, 2015). In many parts of the world, flood is one of the most expensive and devastating natural hazards especially in urban areas (Emmanuel, *et al.*, 2016). Nigeria is one of the luckiest countries on earth in respect to water resources. But we must acknowledge that flooding and water stress in Nigeria, Africa and across the world, are environmental challenges that need intervention to ensure sustainability (Magami, *et al.*, 2014). Periodic floods occur on many rivers; these rivers overflow for reasons like excess rainfall, water ways blockage, etc. (Magami, *et al.*, 2014). Flooding in recent times has become a critically problematic phenomenon of spatio-temporal order and considerably high frequency of occurrence especially in coastal nations / states (Odumosu, *et al.*, 2014). It therefore, becomes necessary to effectively estimate and forecast flooding so as to prevent its ill-effects. On a small area basis, fully empirical solutions could suffice, however as extent coverage increases and consequently drain network becomes more complex, deterministic and reservoir runoff models with graphical capability becomes the best approach. This makes the use of GIS for flood monitoring and control a very efficient tool (Odumosu, *et al.*, 2014). The availability of digital elevation data has made it easy to compute topographic characteristics such as slope, specific catchment area and the wetness index. Often, topographic characteristics are computed from regularly spaced grids of elevation values called digital elevation models (DEMs). River hydraulic geometry is an important input to hydraulic and hydrologic models that route flow along streams, determine the relationship between stage and discharge, and map the potential for flood inundation give the flow in a stream reach. Traditional approaches to quantify river geometry have involved river cross-sections, such as are required for input to the HEC-RAS model (David, *et al.*, 2017). Extending such cross-section based models to large scales has proven complex, and an alternative approach, the Height Above Nearest Drainage (HAND) uses multi-directional flow directions derived from a Digital Elevation Model (DEM) using the D-Infinity method in TauDEM software (http://hydrology.usu.edu/taudem) to

determine the height of each grid cell above the nearest stream along the flow path from that cell to the stream (David, *et al.*, 2017). With this information, the depth of flow in the stream, the potential and depth of flood inundation can be determined (David, *et al.*, 2017). The aim of this study is to model flood inundation of Gbaganu area Minna, Niger State using Height Above Nearest Drainage (HAND) tool with a view of predicting, controlling and managing flood effect by acquiring satellite image of the study area from google Earth, determining the river network and boundary of the study area, downloading and generating the Digital Elevation Models (DEMs) of the study area using remote sensing and conventional ground surveying method, modelling the flow direction of the study area using Height Above the Nearest Drainage (HAND) tool, generating the flood inundation map of the area and validating the map by overlaying the flood inundation map on the DEMs.

2.0 STUDY AREA

As measured on Google Earth Imagery, (2019), Gbeganu is an area covering 16.389hectares located within Minna, Niger state. Situated along Mina-Bida expressway. Gbeganu area has a stream called "Shanu River" within it running through the south-western part of the area. This area lies within 227546.056mE, 1061858.331mN and 228471.065mE, 1061331.973mN.

Study shows that flood occurrences in the Gbaganu Area Minna, Niger State has always caught many in surprise in terms of its magnitude, extent as well as the huge resultant damages of public facilities and lives claimed. This area was one of the worst hit areas, being affected by three (3) major floods within a short period of five (5) years. However, looking at the situation of the environment in Gbeganu Area of Minna, Niger state, there has been a lot of abuse and disturbance on the ecological system in the area like buildings in the water ways, closing up of drainages, improper waste disport, etc. which has been causing a lot of damage to the residents, hence generating a flood inundation map of the area using Height Above Nearest Drainage (HAND) will help depict the regions prone to much effect of flood considering the stream running through the middle of the area. Figure 1.1 is the map of Nigeria shows the location of Niger state, Figure 1.2 is the map of Niger state shows local government areas boundary and depicting the location of Minna in red colour while Figure 2.1 is the map of Gbeganu area of Minna (map of study area)

Figure 2.1: Map of the study area

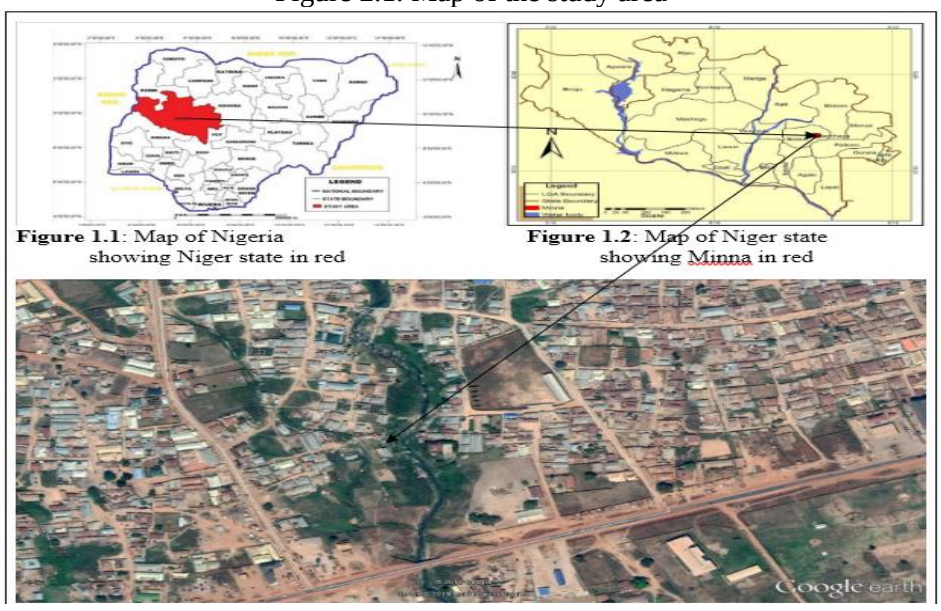

Figure 1.1: Map of Nigeria showing Niger state in red

Figure 1.2: Map of Niger state showing Minna in red

3.0 LITERATURE REVIEW

3.1 Flood

Flood is a natural hazard that resulted from combination of hydrological and meteorological factors. It occurs when a normally dry land areas are temporary inundated due to overflowing of water at the natural or artificial confines of a river, including groundwater caused by prolonged or heavy rainfall. (Martini and Loat, 2007; Klijn, 2009; Anuar, 2018). Hydrologists define flood as a sudden increase in water discharge that caused a sudden peak in the water level. Once flood is over, the water level will drop back to near-constant base flow or no flow. As summarized by Anuar, (2018), flooding is when water and/or sediments exist at unwanted areas other than the water body. Thus, flood can be categorized into different types based on location of occurrence and what cause them. The major ones are the river flood, coastal flood, urban flood and flash flood.

3.2 Flood prone areas

The areas adjacent to a river prone to flooding can be defined as floodplain and floodway. A flood area that is deep with high flow velocities with presence of debris flow that can cause possible erosion is identified as floodway. There should be no development allowed to take place within the floodway area except for critically necessary infrastructure such as bridges (Anuar, 2018). A floodplain on the other hand represents the areas surrounding the river channel (including floodway) that can be inundated during the occurrence of a flood (Anuar, 2018). The boundary of a floodplain cannot be defined as the magnitude of a flood is limitless. The higher a point in the floodplain is, the lesser the probability of inundation. A flood line however can be drawn up to define a floodplain area based on the water level of a flood with specified annual exceedance probability. No development should take place within this flood line. In the field of flood risk management, the confusion is not only arising in use of risk related definition, but also in the naming of different flood maps (Anuar, 2018). For instance, Anuar (2018), proposed four type of flood map namely as flood danger map, flood hazard map, flood vulnerability map and flood damage risk map. In general, flood map can be defined as a map presenting the area prone to flooding at one or more floods with given return periods. Flood maps are created by various institutions and used by many stakeholders. The main producers of flood map either at local scale or basin scale are governmental institution and private company particularly to insurance company or cooperation between the government and private company. Anuar (2018) highlighted that the use of flood maps serves at least one of the three purposes of flood risk management which are: Preventing the build-up of new risks (planning and construction), reducing existing risks, and adapting to changes in risks factors.

3.3 Drainage morphometric analysis using Height Above the Nearest Drainage (HAND) Tool

The most widely recognized methodology for routing flow over a terrain surface represented by a grid DEM is the eight-direction method (D8) where the bearing of steepest plummet towards one of the eight (side and diagonal) neighbouring grid cells is used to represent the flow field (Odumosu, *et al*. 2014). Other methods include the D-infinity multiple flow direction (D∞) (Odumosu, *et al*. 2014) and Rho 8.

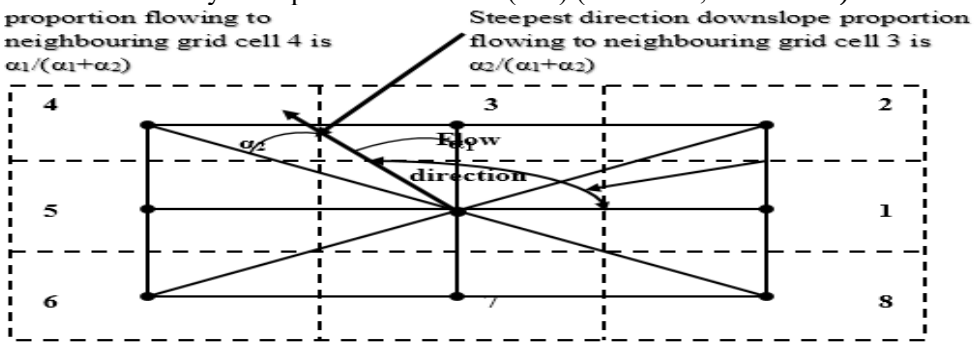

Figure 3.1: D-8 multiple flow direction model (Odumosu, *et al*. 2014)

Flow direction defined as steepest downwards slope on planar triangular facets on a block cantered grid. All flow field methods assign flow from each grid cell to one or more of its adjacent neighbours. In grid DEMs the basic model element is a grid cell, but the same concepts can be applied to any set of topologically connected model elements.

The flow proportions assigned to each downslope element are positive and should satisfy the conservation constraint viz:

$$\sum_j P_{ij} = 1 \quad (3.1)$$

where, P_{ij} denotes the flow proportions assigned to each cell.

Thus, the general accumulation function for each grid is defined as the integration of a loading field over a contributing area as:

$$A = \int_{CA} w.da \quad (3.2)$$

where, A is the general accumulation function, CA denotes the contributing area and integration of loading field is given as w.

Recursive algorithm for evaluation of accumulation in the D8 case that was extended to multiple flow direction methods (Odumosu, *et al*., 2014). Numerically, flow accumulation is evaluated recursively for each element as:

$$A_i = w_i\Delta + \sum_{(k:\, P_{ki}>0)} P_{ki}\, A_k \quad (3.3)$$

where, i is a location in the field, represented numerically by a model element such as grid cell in a DEM and A_i represents the accumulation at that element. The model element area is Δ and the $(k: P_{ki} > 0)$ notation denotes that summation is over the set of k values such that $P > 0$ (i.e., summing the contribution from neighbouring elements k to element i).

Height Above the Nearest Drainage (HAND) metric which was formalized by Renn´o, *et al.,* (2008) is based on the principle of D8 multi-flow direction algorithm. This metric may be more adequate to identify Drainage morphometric different landscape units than the traditionally used elevation above mean sea level. HAND calculates the elevation of each point in the catchment above the nearest stream it drains to, following the flow direction. It thus extracts from the relatively uninformative topographic elevation the far more informative "hydrologic" elevation, thereby increasing the hydrologic information content of elevation data (Nobre *et al*., 2011).

Input data for HAND were stream raster and Digital Elevation Model (DEM), the process was supervised and the flow chart was re-organised and the output given were; watershed, flow direction and fill (flow accumulation area) and basins.

4.0 RESEARCH METHODOLOGY

4.1 Conceptual design

For successful completion of this study an algorithm or work flow that consist the step by step process or procedure to the study was developed. Figure 4.1 shows the work process which begin from the acquisition of the required data which are the satellite imagery, topographical point data samples, and the digital elevation model of Gbaganu area.

The next step is to begin the data processing, which are further classified or divided into image registration, vectorization, boundary and stream network rasterization, drainage morphometric analysis and mapping flood inundation of the area. *Image registration process* make use of the satellite image and the topographical point data samples which produced a geo-referenced satellite image of Gbaganu area, *Vectorization process* make use of the registered satellite imagery, *boundary and stream network rasterization* make use of the vectorised boundary and stream network of the area, the *Drainage morphometric analysis* make use of the Digital Elevation Models (DEMs) data and the stream network raster. The drainage morphometric analysis also involves the fill analysis, the flow accumulation analysis. the flow direction analysis and the basin analysis. These analyses help in the determination of the areas that are very vulnerable to flood and the areas that are not vulnerable to flood and the process of *mapping flood*

inundation of the area involve the usage of Digital Elevation Models, Satellite image, boundary, stream network and the flow accumulation from morphometric analysis.

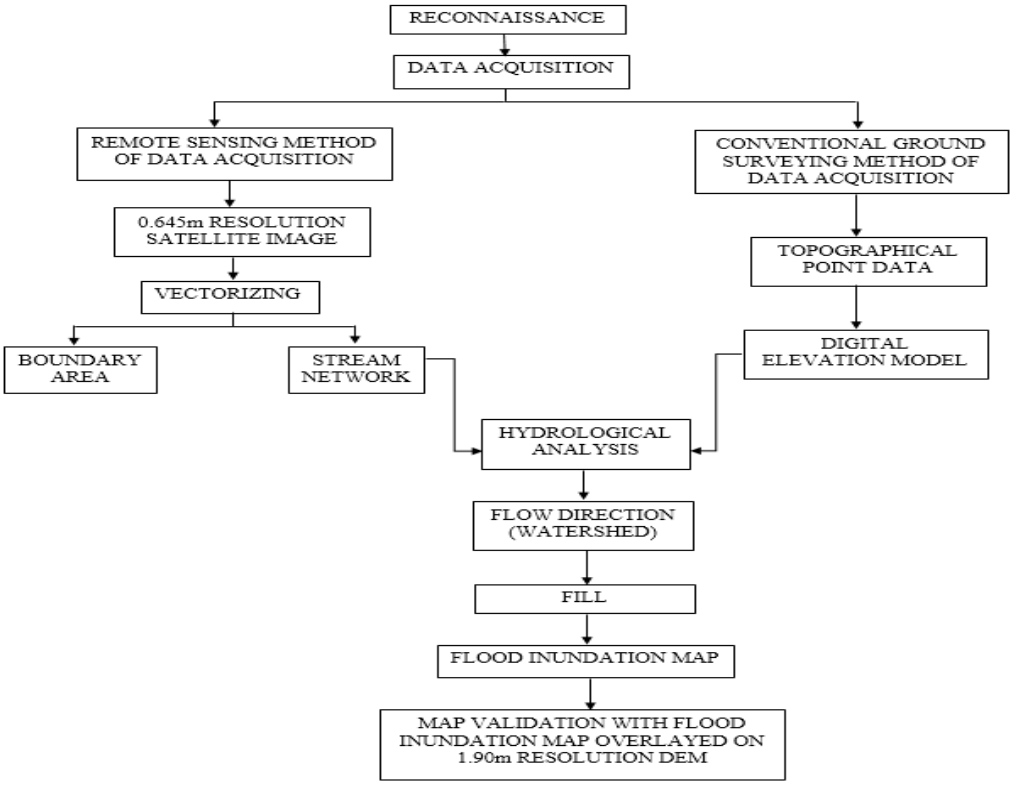

Figure 4.1: Methodology work flow

4.2 Data acquisition

Some of the method of collecting data include point data samples, aerial photogrammetry, remote sensing etc. but for the purpose of this study the method employed were point data sample from ground surveying method and remote sensing method of surveying. The data required for the completion of this study are: (i) Satellite image of the study area, (ii) Point data samples of the study area and (iii) Digital Elevation Models of the study area.

4.2.1 Satellite image

The satellite image of Gbeganu was downloaded from Google Earth which is an open software. After launching the google Earth program, Gbeganu area was searched and zoomed into. Once it got zoomed to the desired resolution (0.645metres), the page was saved.

4.2.2 Point data samples from ground surveying method

A Differential Global Positioning System (DGPS) receivers with model V30 pro was used to acquire the Northing, Easting and Height coordinates of points over the study area. The DGPS base receiver (with serial no.: 10000203 and pin: 0201010131) was setup on station PBBM 7605 with coordinate 228080.1984mE, 1061440.1193mN and 227.6545mH, the rover receiver (with serial no.: 10000346 and pin: 0201010131) was connected to the base receiver. The selected reference geoid was EGM2008 for geoidal height realization. The DGPS was operated on Hi-RTK (High-target Real Time Kinematics) mode after which scattered points were picked all around the study area.

4.2.3 Digital Elevation Models (DEMs)

4.2.3.1 Downloaded SRTM DEM

The Shuttle Radar Topography Mission (SRTM) is an international research effort that obtained Digital Elevation Models (DEMs) on a near-global scale ranging from 56^0 S to 60^0 N, so as to generate the most complete high resolution digital topographic database of the Earth. The downloaded SRTM DEM is of 1-arc second (30m resolution) which covers nearly the entire Niger State. Figure 5.5 shows the DEM of the study area extracted from the downloaded SRTM DEM. The DEM is arranged in tiles each one covering one degree of longitude and one degree of latitude and are named according to their south-western corners.

4.2.3.2 Generated Digital Elevation Model (DEM)

Northing, Easting and Height (N, E and Z) coordinates of points observed on the site were extracted from the entire result given by the Differential Global Positioning System (DGPS). These extracted coordinates were imported into ArcGIS software on which kriging tool was used to generate a 1.90m resolution Digital Elevation Model (DEM) of the study area.

4.3 Image registration

Image registration which also mean image geo-referencing refers to the process of converting photo coordinate or image coordinate to a ground coordinates or geographical coordinates. For the purpose of this study, the downloaded satellite image of the study area was imported into the ArcGIS software and was geo-referenced using coordinates of corner points gotten from the topographic point data samples observed on the site.

4.4 Vectorization

For the course of this study, ArcGIS 10.3.1 software was used for the vectorization of boundary and stream network and also used to extract the Digital Elevation Model (DEM) of the study area. ArcGIS is a geographic information system (GIS) software package developed by Environmental Systems Research Institute (ESRI) that runs on Microsoft windows operating systems, it handles raster, vector and elevation data and also provides viewing, conversion, coordinate projection and other general GIS functions, it has an active user community with a mailing list and online forums.

4.5 Boundary and stream raster depiction

For clear evaluation of this process, a 0.645m resolution satellite image of the area gotten from google Earth program, from where the boundary and stream network were vectorised after the satellite has imported to the ArcMap environment. The vectorised boundary and Stream network were then converted to raster. The converted boundary was then used to mask the DEM to the exact shape of the area.

4.6 Drainage morphometric analysis

4.6.1 Watershed

Watershed is the upslope area contributing flow to a given location. Such an area is also referred to as a basin, catchment, sub-watershed, or contributing area. A sub-watershed is simply part of a hierarchy, implying that a given watershed is part of a larger watershed. Watersheds can be delineated from a DEM by computing the flow direction and using it in the watershed function. The watershed function uses a raster of flow direction to determine contributing area.

4.6.2 Flow direction

Flow direction or drainage network shows the path or the direction the water will follow in the process of flowing. It determines which direction water will flow in a given cell. Based on the direction of the steepest descent in each cell, in addition, the z-value difference and slope are calculated between neighbouring cells. Slope is the ultimate factor of how water flows in any model. Hydrologists use flow direction model to model surface runoff contributes to flooding; flow direction calculates the direction water will flow using slope from neighbouring cells. When water flows in the east direction, it has a value of 1, when it flows

west, it has a value of 16. All 8 adjacent directions at a given can be described using the eight-direction pour point model as given in Figure 3.1.

4.6.3 Flow accumulation (FILL)

The flow accumulation (FILL) function calculates accumulated flow as the accumulated weight of all cells flowing to each downslope cell in the output raster. If no weight raster is provided, a weight of one is applied to each cell, and the values of cells in the output raster will be the number of cells that flow into each cell.

4.7 Mapping flood inundation of the area

The outputs were then used along with the boundary and the 0.645m resolution downloaded satellite image to map regions prone to flood in the area. This map was then overlaid on the DEM for analysis.

5.0 RESULTS AND DISCUSSION OF THE RESULTS

5.1 Results presentation

The downloaded map of the study area from where the boundary and the stream network were vectorised is shown in figure 5.1, the topographical point data (i.e. spot height) of the study area observed with Differential Global Positioning System (DGPS) were shown in figure 5.2, figure 5.3 shows the distribution of the point data over the study area, a 1.90m resolution Digital Elevation Model (DEM) shown in figure 5.4 was generated using the topographical point data while the 30m resolution DEM shown in figure 5.5 was downloaded from Shuttle Radar Topography Mission (SRTM) website, figure 5.6 and 5.7 shows the flow direction (watershed) and the flow accumulation respectively which were the result of the analyses performed using Height Above the Nearest Drainage (HAND) tool on ArcGIS. These results were then further analysed to generate the flood inundation map of Gbaganu area as shown in figure 5.8 which was validated by its correspondence with the wet index of the 1.90m resolution DEM as shown in figure 5.9 and its correlation with the present situation in the area.

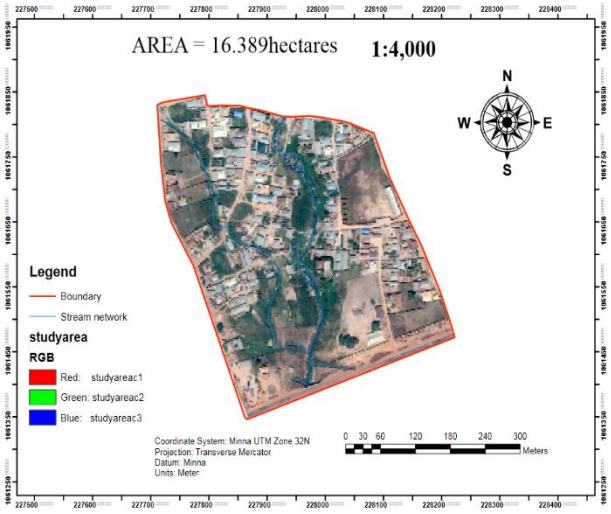

Figure 5.1: Map of the study including boundary and stream network

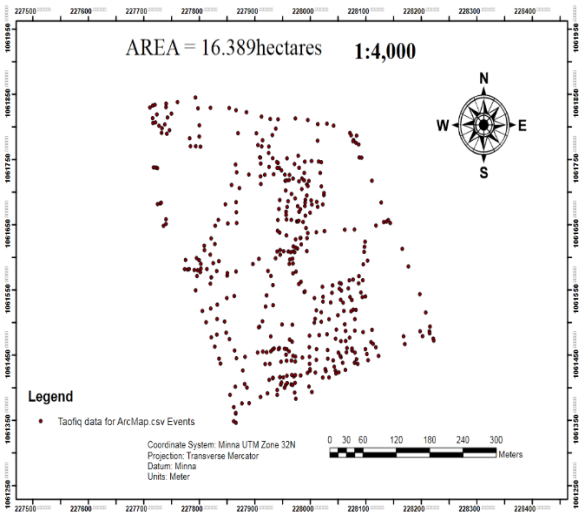

Figure 5.2: Point data gotten from Differential GPS

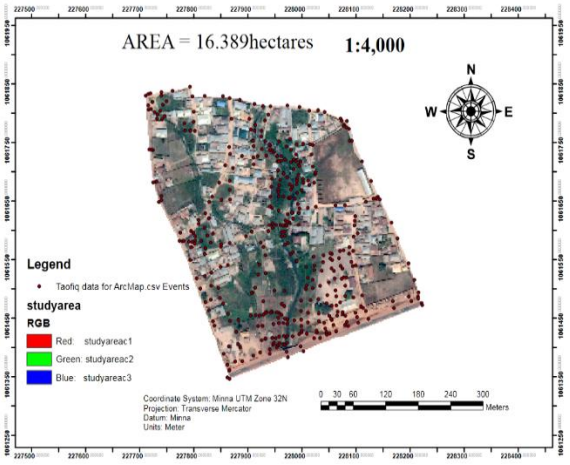

Figure 5.3: Point data distribution over study area

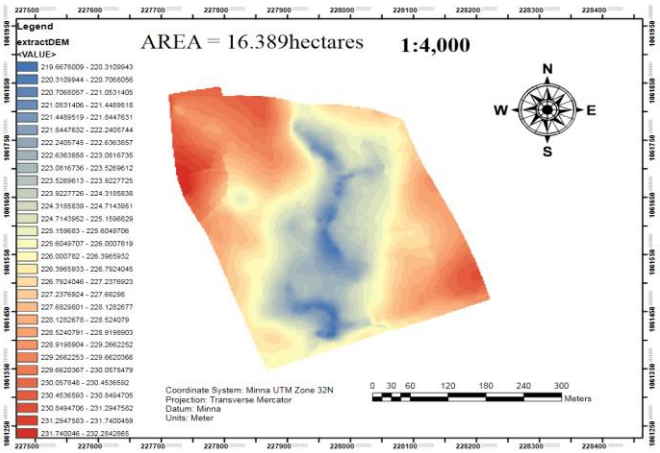

Figure 5.4: DEM generated from point data (using conventional ground survey method)

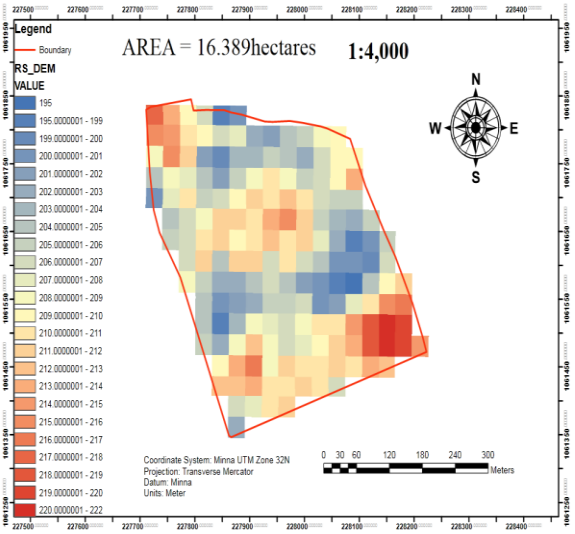

Figure 5.5: DEM downloaded from SRTM (using remote sensing method)

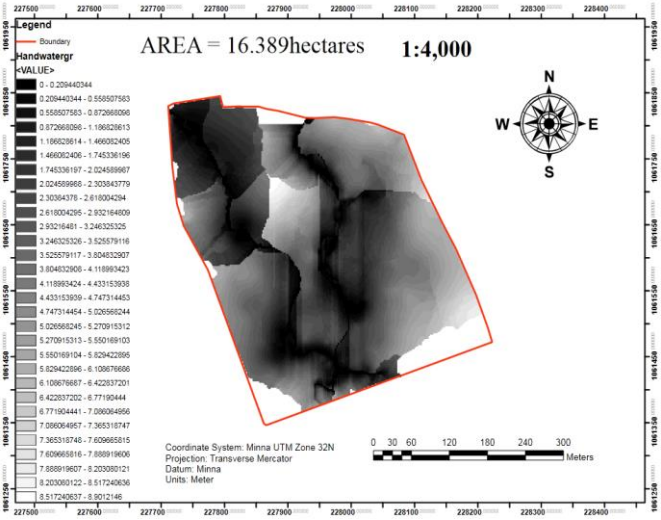

Figure 5.6: Direction of flow of water from High regions to lower regions (watershed)

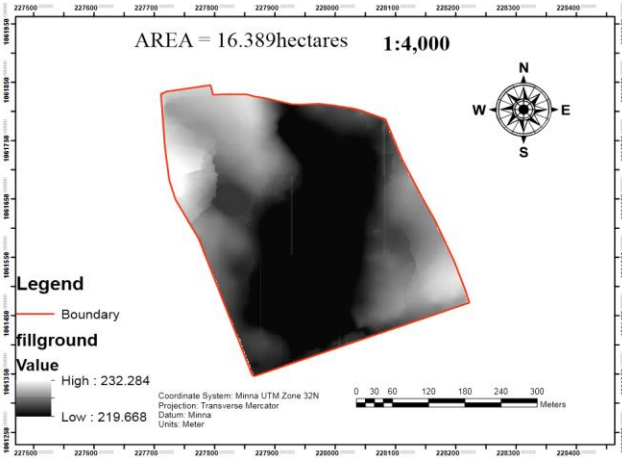

Figure 5.7: Region within the area that could be dammed

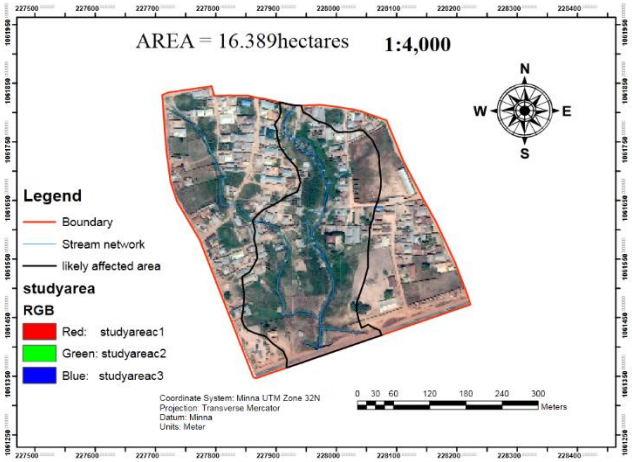

Figure 5.8: Prediction of flood effect within the area

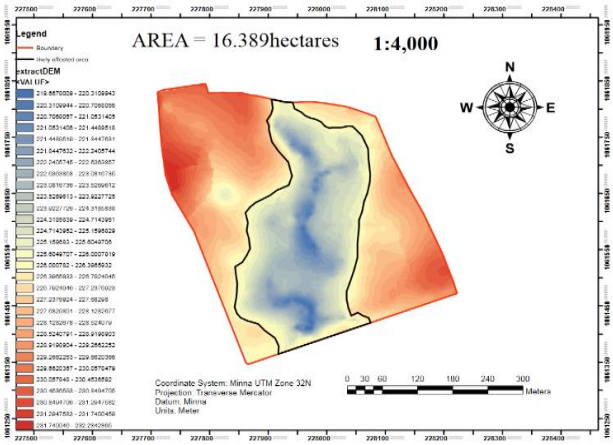

Figure 5.9: Validation of the prediction on 1.9m resolution DEM

5.2 DISCUSSION OF RESULTS

Study area boundary and stream network were vectorised from the 0.645m resolution satellite image downloaded from google earth software as shown in Figure 5.1 both of which were used along with the 1.90m resolution DEM on Height above the Nearest Drainage (HAND) tool for drainage morphometric analyses. Figures 5.2 and 5.3 show the topographical point data observed using Differential Global Positioning System (DGPS) receivers and the distribution over study area which was processed to generate the 1.90m resolution Digital Elevation Model of the study area shown in Figure 5.4.

Figure 5.5 shows the 30m resolution DEM of Gbeganu area about 16.389hectares, extracted from the downloaded SRTM DEM. The output of the drainage morphometric analyses although this was limited by the small area size, gives Figure 5.6 which depicts watershed i.e. direction of flow of water from higher ground to lower surface and Figure 5.7 shows the fill i.e. the regions with high tendency of water concentration (regions water could be dammed) in case of flood occurrence which made it clear that water passing through a region does not guarantee that the area could get flooded in as much as there is enough slope for the water to escape to a lower surface. This was further analysed and overlaid on the study area satellite image to map flood inundation within the area as shown in Figure 5.8. Regions highly susceptible to flood were encapsulated and about 77 buildings were most likely to be affected. Figure 5.9 further shows the correlation of the flood inundation map with the wet index of the 1.90m resolution DEM.

From the flood inundation map produced, development along the water course violates the rules guiding them, this in turn disturbs the ecological cycle, a case is Shanu river running through the area. This might cause continuous flooding of the area, since the river have to find a new course. This might have adverse effect on Gbeganu as a rapid developing area. Also, from the basin analysis and the satellite image, it is discovered that the region prone to flood has be developed with about 77 living edifies and can be inhabited by Gbeganu residence. Conclusively, the wet index part of the DEM were the regions identified by HAND as regions that are highly susceptible to flood.

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

This paper has investigated the drainage morphometry and flood dynamics of Gbeganu via morphometric simulation using Height Above the Nearest Drainage (HAND) tool on ArcGIS software. Flood inundation hazard is very destructive and it's a common phenomenon in Gbeganu, it causes heavy damage to lives, property and economy well-being of the affected area. The morphometric analysis of flood inundation hazard in the area watershed shows that the risk to buildings will be more serious in the nearest future. The implementation of flood countermeasures will contribute to reduced flood

impacts, the identification of priority areas for flood risk reduction using flood inundation map will be helpful to decision makers as they adopt strategies at local and regional scales. Flood inundation mapping considering uncertainties in flood modelling can be most useful for land-use planning in flood risk areas and can help urban planners prioritize their response measures. The prediction of flood situations will be useful for planning and designing structural and non-structural measures. Moreover, a flood inundation map might be used for early warning systems.

RECOMMENDATIONS

1. Development along water body should be monitored by appropriate authority
2. Awareness about the danger of building along flood prone areas should be given to the public by both private and governmental organisations.
3. Measures should be taken against building that fails the vulnerability test along waterways
4. Futuristic measure must be considered when planning for any development to reduce or mitigate unforeseen circumstances.
5. Conventional ground survey method should be used to generate DEM to improve resolution

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Spatio-Temporal Analysis of Urban Sprawl and its Impact on Economic Trees in Gidan Mangoro-Minna, Niger State, Nigeria

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Abstract:

Gidan mangoro, a settlement located along Minna-Bida road in Niger State, derived its name as a result of the abundance of economic trees (mango trees) that are now subjected to continues deforestation due to urban sprawl. Deforestation and biodiversity loss is on increase thereby reducing the carbon sink capacity of the vegetal cover. This research uses satellite imagery Landsat (TM/ETM) and over a period of 15years (2003-2018) to assess spatial changes in the area. ArcGis software 10.5 was used using the supervised image classification technique. Google earth image was used for population data of the study area and for spatial distribution of mango trees. The study revealed an increase of 44.77ha (18.74%) in built-up area in 2018 as compared to 8.87ha (3.70%) in 2003, there was also a decrease in vegetation from 18.47ha (7.74%) in 2003 to 6.59ha (2.76%). The population of Gidan mangoro increased from 1,216 in 2003 to 5,286 in 2018. Mango trees decreased from 695 in 2003 to 158 in 2018, this indicates the rate at which deforestation has taken place in Gidan mangoro. It is therefore recommended that proper zoning ordinances that preserve economic trees and biodiversity should be adhere to for sustainable development in Gidan mangoro and Nigeria at large.

Keywords: *Deforestation, Ecosystem, Vegetation, Urban sprawl, Sustainable Development*

INTRODUCTION

Population growth in urban areas of both develop and developing countries is on the increase, in 2009, over 3.4 billion people in the world resided in urban areas, and this figure is estimated to increase to 6.5 billion by 2050 (United Nations, 2009). Numerous cities across the world have begun to rethink and develop sustainable urban plans so as to guarantee that their growth and expansion processes lead to sustainable outcomes (Gideon, 2010).

In Nigeria however, Nyambo (2010) noted that sustainable development has not been achieved due to the lack of sustainable urbanization and planning approaches that are not implemented appropriately. This has resulted into various negative impacts such as sprawl development, slums, environmental degradation and pollution.

Aim and objectives

The study was aimed at carrying out a spatio-temporal impact assessment of urban sprawl development on Gidan Mangoro, Minna, through the following objectives:

Develop the land use/land cover maps of Gidan mangoro using multi-temporal images of 15years and examine the land consumption and absorption rate.

Examine the spatial changes of Gidan mangoro.

Determine the socio economic implications of the spatial changes in Gidan mangoro.

Study area

Minna the state capital of Niger state in Nigeria lies on latitude 9° 37' North and longitude 6° 33' East, it consists of 25 wards, while Gidan mangoro is at the out-sketch of the town along Mnna-Bida road. The village is about 13.4km from Minna central. It lies within the co-ordinates latitude 9°33'28.8" to 9°34'20.64" North of the equator and longitude 6°28'35.04" to 6°29'52.8" East.

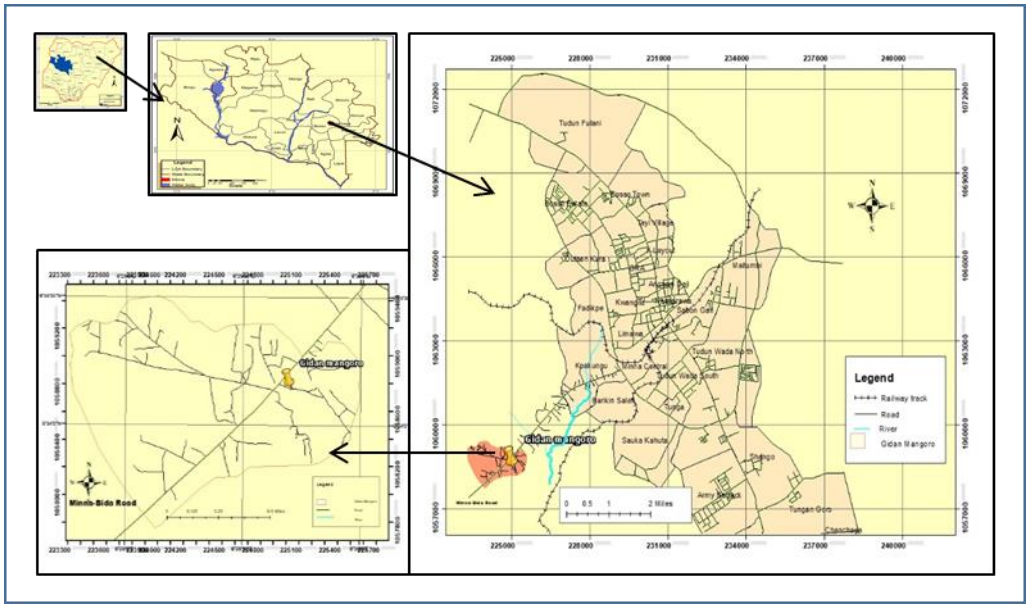

Figure 1: Map of study area.

LITERATURE REVIEW

The world has seen the development and growth of urban areas at a faster pace (Bhat *et al*, 2017), according to the United Nations, the global urban population increased from 1.35 billion in 1970 to 3.63 billion in 2011, which is expected to rise to 6.3 billion by the year 2050 (United Nations, 2012). The rapid expansion of our cities has altered the natural landscape significantly, it has generated enormous environmental, ecosystem, and social impacts (Bhat *et al*, 2017),which are now common phenomenon in developing counties (Liu *et al.* 2011).

The unplanned and uncontrolled rapid growth and development has also resulted into various serious negative effects on urban dwellers and their environment (Chadchan and Shankar, 2012). The inevitable results from this process comprise the spatial extension of towns and cities beyond their initial boundaries to their environs and peripheries with the aim of accommodating the growing urban population (Mosammam, *et al*, 2016). Population growth and urban sprawl indicates human-induced deforestation and modification of natural landscape via the construction of buildings, transportation network, sewage and water supplies put forth various negative impacts on land, biodiversity, vegetation, noise level, air and water qualities, which result to an overall environmental degradation both within a city and in its immediate surrounding area (Wilson and Chakraborty, 2013).

Urban sprawl is one of the major factor contributing to loss of vegetal cover in urban areas most especially in the developing countries (Guida-Johnson et al 2017). Vegetation has numerous impact in an urban environment by way of it providing hydrological, ecological, social and climatic benefits (Munyati and Mboweni, 2013). Vegetation cover most especially trees are largely viewed as an essential component of land cover (Naibbi et al 2014). Studies throughout developing country have continually reported that most urban societies are losing tree cover and other vegetal land use due to wide ranges of anthropogenic activities such as urbanization. As reported by many studies, hardly can we find any vegetation cover that has not been affected by human activities across the world (Hegazy and Kaloop, 2015).

Conceptual Framework

The urban sprawl wheel of Idowu (2017) which explains the factor responsible for urban sprawl was adopted for this study.

Figure 2: Urban Sprawl Wheel
Source: Idowu, 2017.

He explains the factors responsible for urban sprawl to be; increase in population, economic activity, urban growth, new town and housing development, price of land and rental value, income level and choice of individuals, government impact and industrialization, horizontal development pattern, influence of transportation system, liveability factors and change in urban land use.

RESEARCH METHODOLOGY

The study utilized 2003,2006,2009,2012, and 2018 Landsat imageries, hand held Geographic information system (GPS) was used for ground truthing so as to ensure that the features on the ground are in their correct position on the acquired images. The images where classified on ArcGIS 10.5 environment using the supervised classification technique, the statistics generated from the image classification was used to determine and analysed the extent and pattern of urban sprawl in Gidan mangoro. Google earth image of the study area were also used to determine the population of the study area using the historical imagery feature, the population was derived by counting the buildings of each year and multiplying it by national household size of 6. Due to the imagery resolution of google earth imageries (15meters to 15centimeters), the imageries were also digitized on Arcgis 10.5 showing the spatial distribution of mango trees and buildings, the statistics of the digitized image were used to derive the number of mango trees over the years (2003-2018) and thereby used as a basis to determine the economic worth and loss of mango trees in the study area. The valuation method used is the net present value

ANALYSIS AND RESULT

Spatial changes of vegetation cover of Gidanmangoro

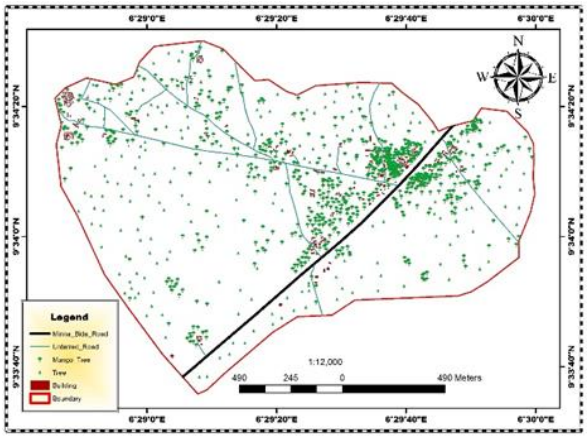

Figure 3: 2003 Spatial distribution of mango trees and built up areas in Gidan mangoro

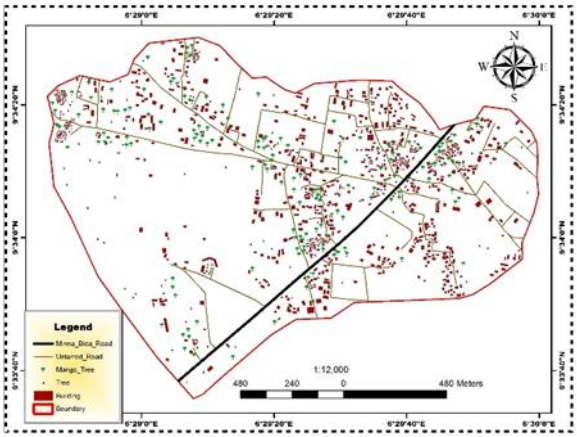

Figure 4: 2018 Spatial distribution of mango trees and built up areas in Gidan mangoro

Figure 1 and 2 shows the changes in Gidan-mangoro between 2003-2018, Gidan mangoro had 203 buildings in 2003, during that period, the settlement was quite small, however in 2012, the number of buildings increased to 881. This indicate the gradual growth of the study area. It was also observed that as the buildings were increasing, there was corresponding decrease in vegetation cover.

Population growth of Gidanmangoro.
The population of Gidanmangoro has increased over the years, this was as a result of the continued increase in the concentration of people.

Table 1: Population of Gidanmangoro (2003-2012)

Year	Number of buildings	Population
2003	203	1,216
2006	236	1,416
2009	385	2,310
2012	427	2,562
2015	622	3,732
2018	881	5,286

The estimated population of Gidan-mangoro was derived using Google earth image of the study area for 2003, 2006, 2009, 2012, 2015 and 2018, the number of buildings were counted and was multiplied by the national household size of 6 as shown in table 1. The population of Gidanamnagoro increased from 1,216 in 2003 to 5,286 in 2018. Gidanamangoro grew 4 times its population in 2003.

Effect of urban sprawl on economic trees

The result in Table 2 indicates the decrease in the number of mango tress over the years which was as a resultant effect of urban sprawl in the area. In 2003, the number of mango trees present were 695, due to deforestation activities for physical development, in 2018 however, the

number of mango trees reduced to 158 mango trees. This means that about 537 trees were deforestrated within the period of 15 years.

Table 2: Number of mango trees in Gidan-mangoro (2003-2018)

Year	Number of mango trees
2003	695
2006	583
2009	409
2012	379
2015	238
2018	158

Economic value of mango trees in Gidanmangoro.

Data in table 2 was used for valuation of mango trees in Gidan-mangoro as shown in table 3, 4, 5 and 6 respectively.

Table 3: 2009 Valuation of mango trees using NPV

Number of mango trees in 2009	409
Average number of fruits per tree	350
Annual number of fruits (409x350)	143,150
Rate per fruit	#5
Gross income from fruits =(143,150x5)	#715,750
Less expenses 30%	#214,723
Net income from fruits	#501,027
Willingness to pay for trees for protection of environment (#20,000x409)	#8,180,000
Willingness to pay for preservation of trees for future use (#15,000x409)	#6,135,000
Net income from mango trees	#14,315,000

The number of mango trees in 2009 were 409, and the average number of fruit per mango tree is 350, this was used to get the annual number of fruits to be 143,150. A fruit was sold at a rate of 5 naira, therefore 5 was multiplied by the annual number of fruits to get the gross income from fruits (#715,750), the less expenses is 30% was multiplied by the gross income gave #214,723. 214,723 was then deducted from gross income to get the net income from fruits. Willingness to pay for trees for protection of environment (#20,000) and Willingness to pay for preservation of trees for future use (#15,000) were gotten from the questionnaire administered to the developers, they were both separately multiplied by the number of trees and then added together which gave #14,315,000.

Table 4: 2012 Valuation of mango trees using NPV

Number of mango trees in 2012	379
Average number of fruits per tree	350
Annual number of fruits (379x350)	132650
Rate per fruit	#5
Gross income from fruits =(132650x5)	#663,250
Less expenses 30%	198,975
Net income from fruits	#464,275
Willingness to pay for trees for protection of environment (#15,000 x 379)	#5,685,000
Willingness to pay for preservation of trees for future use (#10,000 x 379)	#3,790,000
Net income from mango trees	#9,939,275

In 2012, the number of mango trees is 379, and the average number of fruit per mango tree is 350, this was used to get the annual number of fruits to be 132,650. A fruit was sold at a rate of 5 naira, therefore 5 was multiplied by the annual number of fruits to get the gross income from fruits 663,250, the less expenses which is 30% was then multiplied by the gross income which is equal to #198,975. #198,975 was then deducted from gross income (#663,250) to get the net income from fruits. Willingness to pay for trees for protection of environment (#15,000) and Willingness to pay for preservation of trees for future use (#10,000) were also gotten from the questionnaire administered, they were both separately multiplied by the number of trees and then added together which gave #9,939,275.

Table 5: 2015 Valuation of mango trees using NPV

Number of mango trees in 2015	238
Average number of fruits per tree	350
Annual number of fruits(154x350)	83,300
Rate per fruit	#5
Gross income from fruits (83300x5)	#416500
Less expenses 30%	#124,950
Net income from fruits	#291,550
Willingness to pay for trees for protection of environment (#15,000x238)	#3,570,000
Willingness to pay for preservation of trees for future use (#15,000x238)	#3,570,000
Net income from mango trees	#7,431,550

In the valuation of 2015, the number of mango trees is 238, the net income from fruit is #291,550 while the net income from mango trees is #7,431,550.

Table 6: 2018 Valuation of mango trees using NPV

Number of mango trees in 2018	154
Average number of fruits per tree	350
Annual number of fruits (154x350)	53,900
Rate per fruit	#5
Gross income from fruit (53,900x5)	#269,500
Less expenses 30%	#80,850
Net income from fruits	#188,650
Willingness to pay for trees for protection of environment (#10,000x154)	#1,540,000
Willingness to pay for preservation of trees for future use (#10,000x154)	#1,540,000
Net income from mango trees	#3,080,000

The number of trees in 2018 was 154, and the annual number of fruit is 53,999, the net income from fruits is #188,650, the net income of mango tree is #3,080,000. Comparing 2009 and 2018, the difference between the two years is #11,235,000, this indicates a huge reduction in economic worth of mango trees.

FINDINGS AND DISCUSSIONS

United Nation predicted and projected the continued increase in population and growth of cites, numerous researchers also wrote on the changes in LULC of cites and buildings springing up at the detriment of vegetal cover. Gidan mangoro is not an exception to the aforementioned as it has also experience drastic changes in its land use pattern over the years, in 2018, Built-up areas were noticed to be springing up more rapidly at the detriment of trees showing the sprawl effect. The population has also increased over the years, the population of Gidan mangoro

increased over time from an estimate of 1,216 in 2003 to 5,286 in 2018. Urban sprawl has also resulted to the decrease in the mango trees from an estimate of 695 in 2003, to an estimate of 158 in 2018. The economic worth of the mango trees was determined using the net present value (NPV), in 2009, the net income from mango trees was #14,315,000 naira, while in 2018 it was #3,080,000 naira, this indicates about #11,235,000 economic lost from mango trees in the community.

CONCLUSION

The rate at which physical development are springing up at the detriment of vegetal cover is quite alarming, this has posed a great concern on academicians as well as city planners. As population would continue to increase, so shall the demand for housing, therefore built-up area will keep increasing at the expense of other Land uses, if regulation and proper planning is not put in place, there will be no mango trees left in Gidan mangoro. Therefore, the planning of Gidan mangoro should not be left to chance, it should be guided by developmental strategies and plans so as to ensure sustainable development of our environment.

RECOMMENDATIONS

Considering the gradual increase of built-up areas in Gidan mangoro, the settlement should be guided by development plan, building developers should be enlightened on the need to conserve trees during the cause of clearing and construction. Reforestation should be made mandatory after any deforestation activity. In addition, polices should be put in place to protect any cultivatable land. Enlightenment campaign programs should be organized for the natives to enlighten them on the need for conservation of the trees in their environment.

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APPENDIX

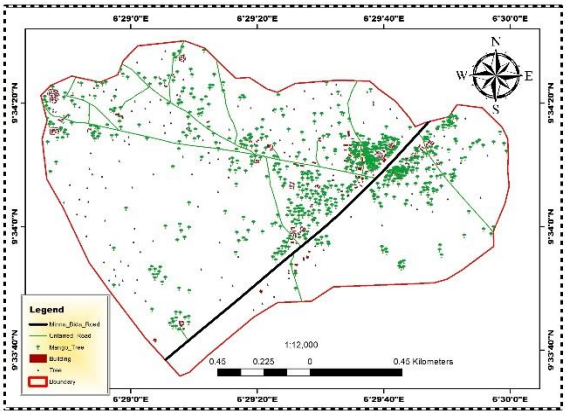

Figure 1: 2006 Distribution of mango trees and built up areas in Gidanmangoro

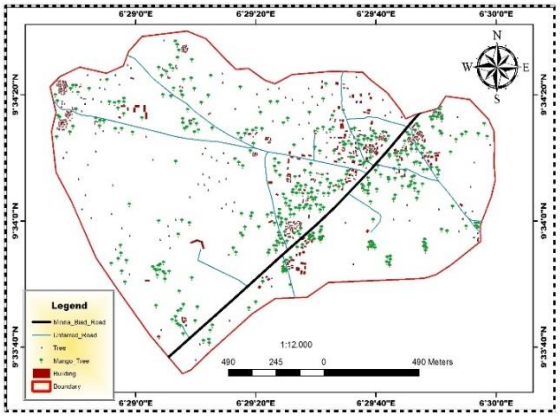

Figure 2: 2009 Distribution of mango trees and built up areas in Gidanmangoro

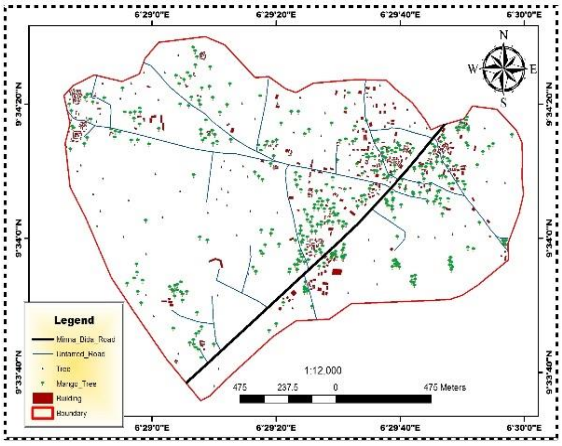

Figure 3: 2012 Distribution of mango trees and built up areas in Gidanmangoro

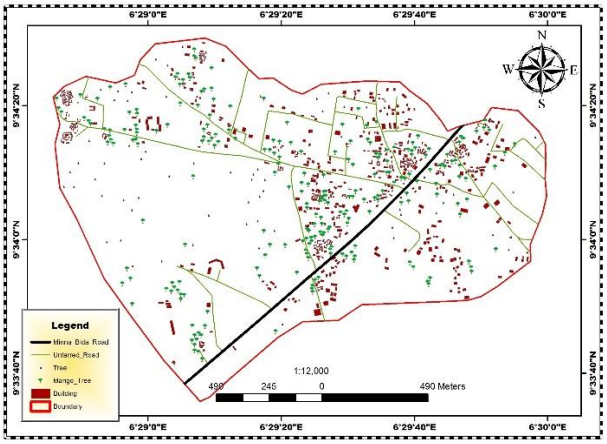

Figure 4: 2015 Distribution of mango trees and built up Areas in Gidanmangoro

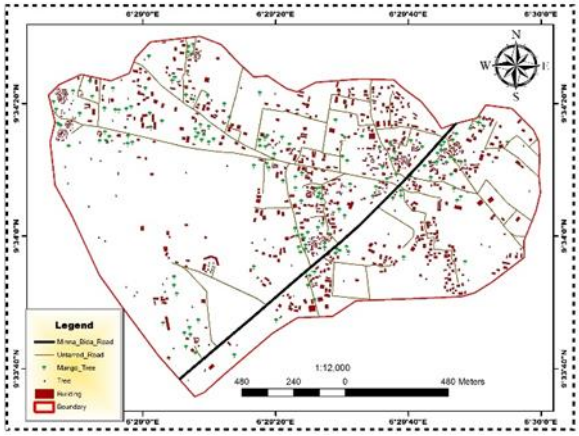

Figure 5: 2018 Distribution of mango trees and built up areas in Gidanmangoro

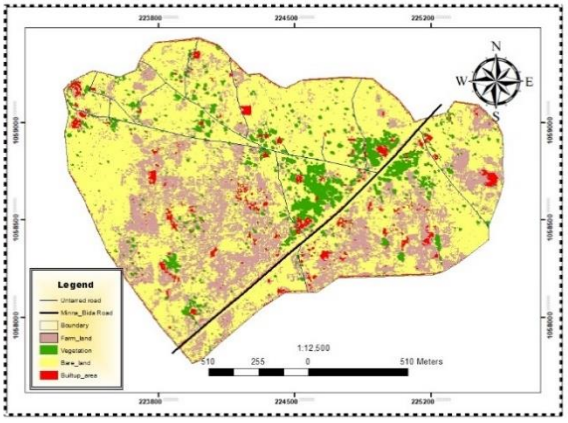

Figure 6: 2003 LULC of Gidan mangoro

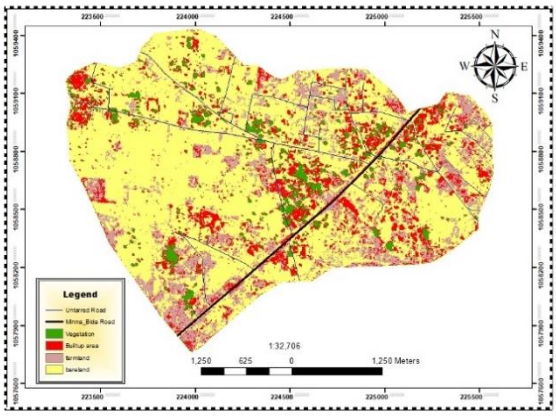

Figure 7:2018 LULC of Gidan mangoro

Table 1: coordinate of trees used for ground truthing

S/N	Coordinate of Trees used for Ground truthing
1	9°34'1.30"N 6°29'25.85"E
2	9°33'58.95"N 6°29'27.60"E
3	9°33'58.02"N 6°29'27.37"E
4	9°33'57.08"N 6°29'25.31"E
5	9°33'57.82"N 6°29'29.21"E

Table 2: Change in the distribution of land use/land cover in Gidan mangoro

Land use/Land cover	2003 (ha)	Area (%)	2006 (ha)	Area (%)	2009 (ha)	Area (%)	2012 (ha)	Area (%)	2015 (ha)	Area (ha)	2018 (ha)	Area (ha)
Farmland	64.56	27.00	62.51	26.19	60.00	25.14	58.00	24.30	56.13	23.51	54.44	22.82
Bare-land	146.80	61.56	144.02	60.34	148.02	62.01	150.58	63.08	144.6	60.58	132.9	55.68
Vegetation	18.47	7.74	16.01	6.71	12.01	5.03	10.05	4.21	9.99	4.19	6.59	2.76
Built-up area	8.87	3.70	16.16	6.77	18.67	7.82	20.07	8.41	27.98	11.72	44.77	18.74
Total	238.7	100	238.7	100	238.7	100	238.7	100	238.7	100	238.7	100

Appraisal of Informal Access to Land for Housing Delivery in Karu Urban Area of Nasarawa State, Nigeria

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Abstract

Failure of formal land management system to provide planned land for orderly development has given rise to alternative ways to ensure access to affordable urban land, which is informal land management. This study is aimed at appraising informal access to land for housing delivery in Karu urban area of Nasarawa State in Nigeria. To achieve this, the study identified procedures for informal land acquisition; identified determinants of access to land through informal channels; evaluated the effect of informal land to housing delivery; and examine the relationship between informal access to land and housing delivery. A total of 375 questionnaires were administered in five neighbourhoods of Karu, targeted at landholding households' head. Both descriptive and inferential statistics were employed for the research analysis. The findings revealed that there was contribution from the access to informal land to housing delivery, with a calculated value of 206.164 greater than the chi-square critical value of 9.488. The study also revealed that informal land which is 78.7% and affordability of land registration with 64.1% were the best strategies of making informal land process more efficient in the study area. Hence, the study recommends land regularization, improvement of tenure security and transparent systems in transferring land right by the government.

Keywords: *Access, Informal land, Housing delivery, Urban area, Land regularization.*

BACKGROUND TO THE STUDY

Land is a tangible and durable platform for socio-economic development because it supplies the platform for all human endeavours; it is vital to growth and housing delivery in any society as well as fundamental elements in property construction process. Its acquisition is necessary to achieving sustainably efficient housing delivery in urban setting (Yakub, 2014; Owoeye and Adedeji, 2015). Owoeye and Adedeji (2015) opined that access to land and rights inherent in property are essential to economic growth and advancement of any nation depending on effectiveness of land distribution amongst the people and competing urban uses. Omirin (2002) observed that acquisition of land with unconstrained access, affordability, ease of transaction as well as security of the owner's right is a tool against poverty and homelessness.

It has since been recognized that formal land markets conditioned by formal land delivery systems have been unsuccessful in providing affordable land to the urban poor (UNCHS, 1997). Formal land markets and land delivery systems tend to serve the rich who can afford the high land prices, leaving the urban poor to obtain land in the informal land markets. Meanwhile, there is no doubt the urban poor continue to play important role in the urban economy and therefore recognizing that their existence in urban areas forms an integral part of cities in developing world, it becomes imperative that alternative ways and means are devised to ensure access to affordable urban land (Agyei-Boateng, 2010). Land access and tenure security for the urban poor thus become significant in creating inclusive cities that cater for the housing need of all, irrespective of their socio-economy class.

In Nigeria, despite the existence of several laws passed to regulate and control urban land delivery access to land in particular for the urban poor through the formal mechanism has been unsuccessful. In a study carried out on informal land delivery in Karu Urban Area it was revealed that informal land delivery is responsible for the supply of 85.2% of the total built-up area (Adamu 2014). This finding is in consonant with the study carried on five Anglophone cities of Africa revealing that informal land channel provides access to land for the majority of people irrespective of their socio-economic class (Rakodi 2005). The flexibility of this method has been the catalyst for its dominant role in providing land for housing, despite its deficiency for being uncoordinated, considered illegal but socially acceptable (Adamu, 2014; Rakodi, 2005). These studies however, did not reflect the relationship between informal access to land and housing delivery in a specific context nor establishing local determinants of accessing land via the informal mechanism.

Majority of Karu urban area can better be described as a settlement characterised by high density and uncoordinated residential houses located in poor environment, and often described as slums and illegal settlements (Isma'il, Ishaku, Yahaya, Tanko and Ahmed, 2015). The reason being that these structures were built without title to land and approved building permits due to the problems of land acquisition and the bureaucratic bottlenecks in the processing of building permits. It is on these premises that, this study aimed at analysing informal access to land for housing delivery, identifying procedures for informal land acquisition and the determinants of access to land through informal channel by evaluating the effect of informal land to housing delivery and examine the relationship between informal access to land and housing delivery.

LITERATURE REVIEW

The concept 'informal' is an umbrella term, used to capture a variety of practices which vary from one context to another. Some people refer to these practices as neo-customary, others call them quasi-customary practices, and still others call them ''living law", (UN-Habitat 2010) on the other hand, the term informal urban land delivery system is used to talk about a variety of urban land transactions, exchanges and transfers that are not recognized by the state as legal, but which are nevertheless socially acceptable as legitimate by a variety of urban actors. Antwi (2002), defined informal land delivery as transactions in land outside the government legal system for which the necessary government proscriptions for formalizations have not been met. Kironde (1995) defined informal land delivery as a delivery system where the allocation or transference of land is outside the ambit of the procedures laid down by the government. Such land will usually be privately "owned" which we mean the land in question is in the control of the people who, by virtue of, for example, earlier occupation or acquisition, or by virtue of customary tenure, command recognized authority over this land (irrespective of laws that may declare all land to be publicly owned). In urban areas such land is usually unplanned.

Informal land market is a hybrid of a variety of practices and contains elements of customary/civil code law and social practices adapted to suit existing urban conditions. Although this market is, according to law, illegal, the state (or some of its agents) is often complicit in its functioning. (UN-Habitat- Urban Land Market 2010). This study therefore, considers informal land delivery system as a land delivery system that allocates, alienates, adjudicates land transaction outside formal structures of the state, but through social (customary) practices in areas declared as urban by state laws. Like the formal urban land

market, informal delivery system consists of a variety of institutions which supports, facilitate, regulate and arbitrate informal land transactions. These include state officials, such as local government councillors, traditional leaders, chiefs, community leaders, and community and family networks. Like formal markets, these regulatory bodies can be effective in facilitating exchange or can be overly restrictive and make it more difficult for (some) poor people to access land.

Keivani et al. (2008) documented the successes of informal access to land for housing delivery in countries such as Iran, Singapore, and Netherlands and Finland. They observed that the Iranian government was able to achieve land and housing market success through the expansion of the stock of low-income urban housing by directly providing land for housing construction to individuals and organizations. Iran government bypassed conventional urban land and housing markets and their associated short-comings through getting involved in public-private joint venture schemes. This approach has proved to be a more effective mechanism for promoting private sector housing provision that reaches lower income households than a process left entirely in the hands of market forces in Iran. Nkurunziza (2007) analysed and explained the nature of the institutions that are responsible for the regulation and structuring of the land delivery processes of informal settlements in Kampala. It was discovered by this author that non-state institutions are diverse in nature as a result of different normative regulation that dictated market exchange and customary practices involved in this system.

Similarly, a study carried out by Kironde (1995) which assessed the level of low-income households and communities in accessing land for housing delivery in Dares Salaam and discovered that most land was owned by the minority while majority declared willingness to acquire plots of land. The study further explained that the poor had a better chance of accessing urban land if the efforts of different actors involved in informal land delivery and system was well harnessed (Masum et al.,2016) argued that informal land and housing development was a manifestation of the absence of favourable laws and bureaucratic frameworks for formal land delivery system. They added that government should deal with such problems through a preventive approach by taking the initiative to develop a pro-poor land development policy that which will embrace poverty alleviating features and will constitute a bridge between formal and informal land delivery systems.

Remote sensing and geographical information system (GIS) has been successfully employed in monitoring and mapping urban sprawl in Karu Urban Area of Nasarawa State, Nigeria (Rikko and Laka, 2013). It was revealed that a more pronounced physical development was noticed along the highway and the settlements nearer to Abuja such as Mararaba, Karu, Nyanya and Masaka than others settlements. They ascribed this development to influx of migrant residents from other parts of the country. Owoeye and Adedeji (2015) conducted a study to identify problem associated with urban land acquisition for sustainable housing delivery in Akure. It was revealed that accessing land for housing delivery in Akure is becoming highly problematic owing to increasing population growth and informal land delivery system. Oloyede et al. (2011) remarked in their work on informal land market that there was continuous patronage of the informal land market by prospective real estate investor s particularly in south-western towns and cities in Nigeria over the years. They attributed this situation to the failure of the land use decree of 1978 as the major cause of the continuous growth of informal land

markets and concluded that reforming the informal land market system in Nigeria could be a question of political will rather than technical approach in the interest of the masses.
Furthermore, Ugonabo and Emoh (2013) examined the major challenges militating against housing development and delivery in Anambra State of Nigeria, the study identified lack of secure access to land as one of the factors inhibiting effective housing development and delivery in the State. However, these studies were not geared towards examining the relationship between informal access to land and housing delivery

METHODOLOGY

Karu Urban Area (KUA) is located in the territorial jurisdiction of Karu Local Government Area of Nasarawa State Nigeria, lying within latitudes 8º 5"N and 10º 42"E and longitudes 7º 54"E and 9º 25'N east of the Greenwich Meridian. Karu Urban Area is considered a planning area made up of a geographic space of about 40,000ha (NUDB, 2009). The designated area shares common boundaries with the Federal Capital Territory (FCT) Abuja, to the west, Keffi Local Government Area (LGA) to the south, Nasarawa LGA to the west in Nasarawa Sate and Jaba Local Government Area of Kaduna state to the north. The main urban settlements comprising of *Mararaba, Koroduma, New Karu, NyanyaGwandara and Masaka are the main focus of this study which includes smaller areas that have been overtaken by new urban development.*

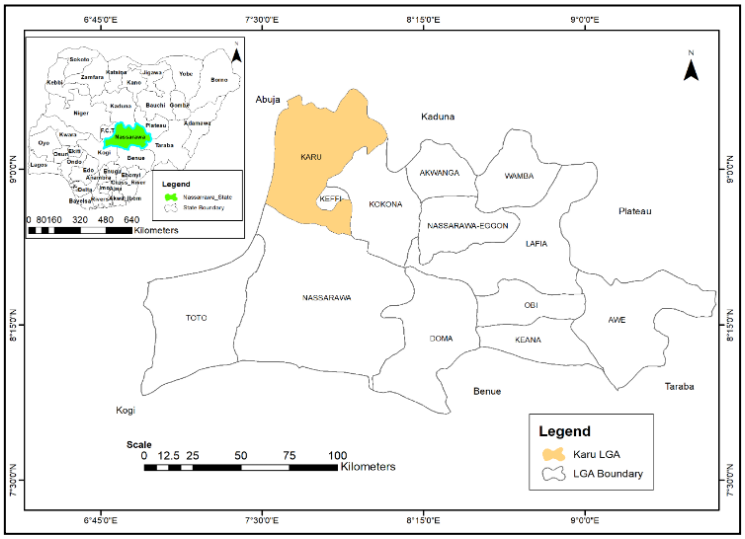

Figure 1*:* Karu local government area in Nassarawa State
Source: *Nassarawa State Ministry of Lands and Survey (2016)*

The study is limited to the five major residential districts of Karu Urban Area namely (Mararaba, Kuruduma, New Karu, Nyanya Gwandara, and Masaka).
The sample frame used was the households, represented by the household heads as primary target respondents. Other respondents were the sampled stakeholders that includes; the Landholding households, the registered professionals, properties agents and Estate developers. However, Simple Random Sampling technique was adopted in administering 296 questionnaires to the household heads in the residential neighbourhoods of Karu. Stratified Sampling technique was adopted in the selection of landholding households' head, agents,

professionals and developers. Questionnaires were purposively administered to 15 land agents who have offices in the five different strata, three (3) from each, 15 experts (3 from each stratum) from each professional field, that is, Land Surveyors, Town Planners, the Estate Surveyors, and Lawyers, were administered questionnaire, while 15 questionnaires were administered to developers with estates in the study area. The existing procedures for informal land access was schematically represented, descriptive statistics were used to analysed the determinants of access to land through informal channels and the effect of informal land to housing delivery, while the relationship between informal access to land and housing delivery was analysed using Chi-square test.

RESULTS AND DISCUSSION

Procedures for Informal Land Acquisition

Procedures for acquiring land in Karu as revealed from the field shows that informal lands were controlled by land holding family, individual land owners (chiefs or family heads and community land) and other actors involved. In the procedures, prospective buyers and sellers declare their interest to buy or sell land through the land agents and the process continues till the transaction is completed as shown in Figure 2.

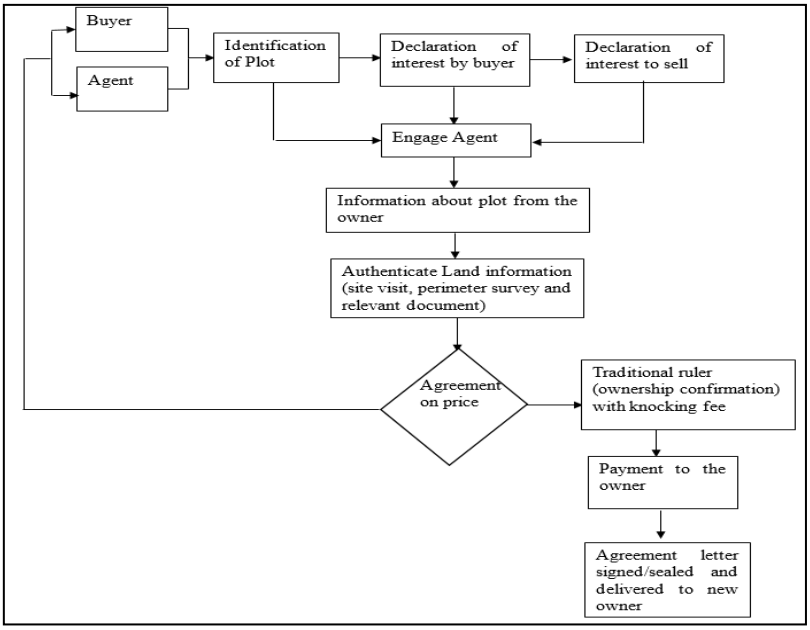

Figure 2: *Flow chart for informal land access procedure in Karu Urban Area*

Determinants of Access to Land through Informal Channels

One of the determinants of access to land through informal channel is affordability of Land. Figure 3, shows that out of 296 households who acquired their land through direct purchase, 54.2 % spent between ₦500,000 – ₦999,000 to acquire their land, this high percentage may be attributed to relative low cost of the informal land.

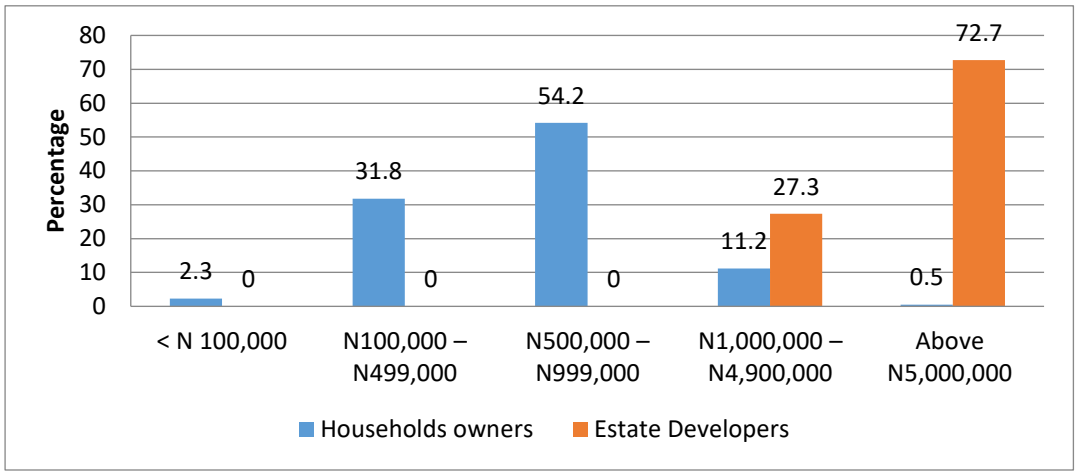

Figure 3: Affordability of Land

However, 72.7 % of the Estate developers who purchased their lands through direct purchase spent ₦5,000,000 and above to purchased their land while the remaining 27.3 % of the developers spent between ₦1,000,000 – ₦4,900,000.The price variations are also a factor of; location, size of land purchased, period of land acquisition, and channel of delivery among others. Affordability of informal land is a major determinants of access to land. It was therefore necessary for this research to verified this assertion in Karu Urban area.

Another determining factor for informal access to land in Karu urban Area is the flexibility in terms of plot sizes. The Results in Figure 4 depicts that various sizes of plots are developed by different clients. From Figure 4 it shows that 63.4 % of the 238 household owners said that their developed plot size ranges between 450sqm-900sqm while 92.9 % of the Estate developers claimed to have developed land in hectares. This indicates that most of the developed lands by individual household owners in the study area are less than 900sqm and most land developed by developers are in hectares. The implication to this is that these different sizes of plots developed are a product of magnitude of use, status and ability to purchase. However, this also informs the flexible pattern of accessing plot land through the informal channel as against the rigid nature associated with the formal channel.

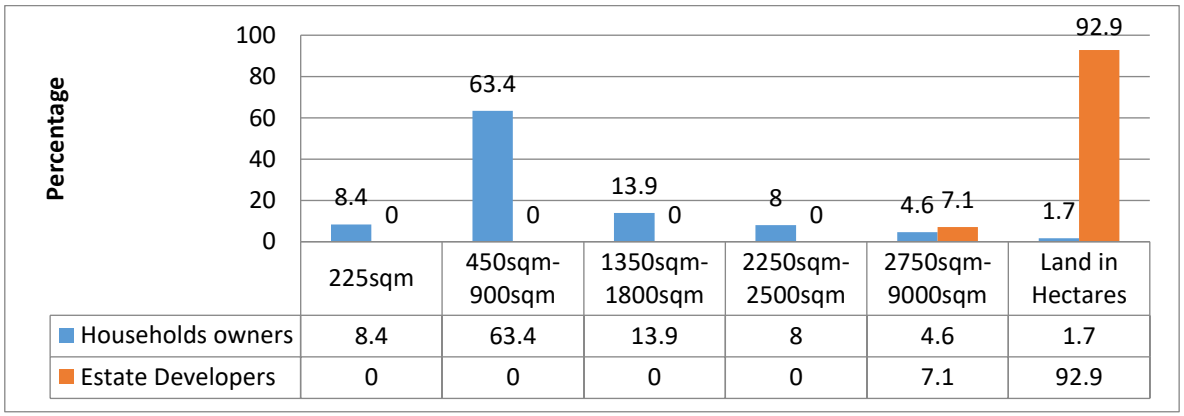

Figure 4: Flexibility of Plot Sizes

Reliability of the informal access to land for all irrespective of socio-economic status is one of the attracting factors for majority of people who access land through this channel (Rakodi and Leduka, 2003). Figure 5 shows that the households' heads and developers who said informal land delivery is absolutely reliable in the study area are 71.6 percent and 85.7 percent respectively which indicates that informal land delivery is widely accepted by the respondents.

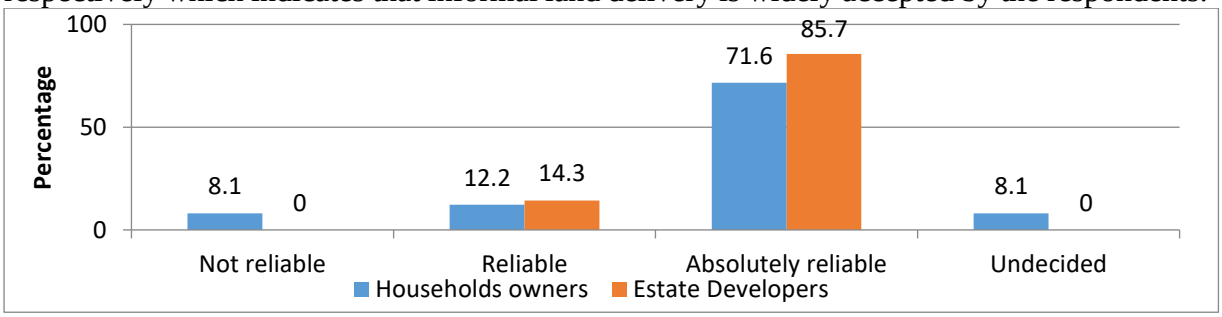

Figure 5: Reliability of Informal Land Delivery Channels

This finding therefore validates the findings by Rakodi andLeduka,(2003), that informal land has been reliable in providing solution to housing crisis due inadequacy of land.

There are other determinants of access to informal land in Karu. Figure 6 shows that 45.3 % of the household owners said availability of land through informal channel was what influenced their choice.

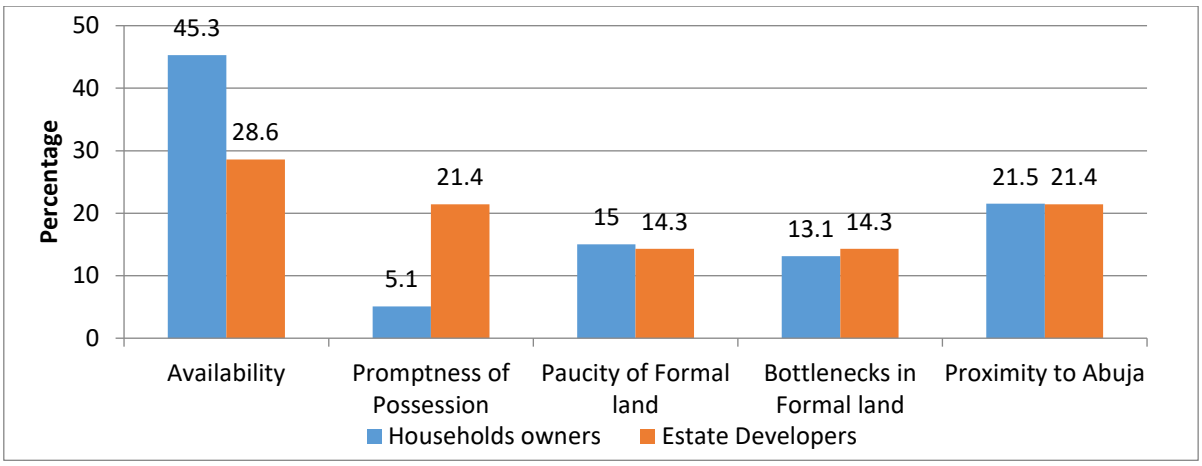

Figure 6: Other Determinants of Informal Land in Karu Urban Area

Meanwhile, 28.6 % of the Estate developers also claimed that the availability of land through this channel influenced their choice. 21.4 % and 14.3 % of Estate developers claimed promptness of possession, and paucity of formal land respectively. Likewise those who claimed bottleneck to access formal land and the remaining 21.5 % of individual house owners claimed proximity of the study area to Abuja. Other determinants that have driven the sustainability of informal land market is its ability to make readily available, prompt possession, and capacity to play alternative role of providing residential land where the formal channel has failed. This implies that some of the land users will still prefer formal land if available and easily accessible.

Effects of Informal Land to Housing Delivery

This section describes in detail the effects of informal access to land on housing delivery.

Table 1: Effects of Informal Land on Housing Delivery

	Strongly Disagree		Disagree		Undecided		Agree		Strongly Agree	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Making Land Delivery Affordable	9	2.5	15	4.2	46	13.0	102	28.9	181	51.3
Provision of Better Alternative Access to Land	3	0.8	9	2.5	18	5.1	119	33.7	204	57.8
Provision of Land to Various Socio-Economic Class of the Society	11	3.1	15	4.2	14	4.0	120	34.0	193	54.7
Encourage Incremental Housing Development	9	2.5	15	4.2	13	3.7	161	45.6	155	43.9
Potential to Making Development Haphazard	29	8.2	110	31.2	34	9.6	128	36.3	52	14.7
Potential for Double Sale of Land	34	9.6	143	40.5	34	9.6	99	28.0	43	12.2

Results in Table 1 indicate affordability of land as one of the relationships that exists between the access to land and housing delivery. The informal access in respect to land delivery has made land relatively affordable. The findings revealed that 51.3 % and 28.9 % of the respondents strongly agreed and agreed respectively with the item. The implication of reduced cost for housing development can be attributed to relative affordability of land. High cost for land equals increase in the cost of housing construction.

This study is in conformity with studies carried out by Djeroh (2005) and Adamu (2014) who affirmed that informal access to land has provided a better alternative to land for residential development. This assertion was tested and varified to be true in Karu Urban Area and the findings are presented in Table 1. The study revealed the perceptions of respondents on whether informal land delivery has provided alternative access to land. It indicates that informal land delivery has been a better alternative access to land as 57.8% of the respondents strongly agreed and 33.7% agreed. This collaborate with the findings of Rakod (2005) and Antwi (2002) that informal land channel has provided solution to housing crisis in most African cities where the formal channel has failed.

Another significant relationship the informal land has contributed immensely to housing delivery in Karu Urban Area is in the aspect of providing access to people of various cadre in the society. This is backed up by findings shown in Table 1, which indicates that informal land delivery makes land available for the housing need of various socio-economic classes of the society as the population of the respondents that strongly agreed with item (54.7% and 34.0%) are far higher than the respondents that disagreed. This supports the findings of Leduka, (2006) and Rakodi, (2005), that informal land delivery provides access to land for housing development for the majority of people irrespective of their socioeconomic class.

Another interesting influence of informal land access on housing delivery is the fact the system has provided avenue where developers can develop their houses at their own pace as their capital enables them. Table 1 provides perceptions of respondents whether this assertion is applicable in Karu Urban Area. This indicates that informal land delivery encourages incremental housing development in Karu Urban Area as indicated by 45.6% and 43.9% agreement rate as against 4.2% and 2.5% disagreement rate. This depicts the flexibility associated with informal access to land as it has the capacity to providing secure access to land and enabling households to construct their dwellings incrementally (in phases) as their

resources allow at a significantly lower cost and convenience, than conventional public housing programmes.

Haphazard or uncoordinated development does not in any way influence the delivery of housing stock however it does relate to housing delivery in terms of the physical characteristics of the built environment. Table 19 shows the perceptions of respondents to ascertain the possibility of informal land delivery encouraging haphazard development. The Table 1 indicates that informal land delivery has the potential to make development haphazard. The population that agrees is 51% as compared by 39.4 % that disagreed. This tallies with the findings of Rakodi and Leduka (2003) that informal land transactions are susceptible to influencing haphazard and uncoordinated housing development. This can be attributed to near absence and ineffective planning mechanisms in informal land transactions.

The result also shows the respondents' perception on the potential of informal land delivery to encourage double sale of land. The responses gotten indicates that more respondents (9.6 % and 40.5 %) disagreed than the respondents that agreed that informal land delivery encourages double sale of land. This indicates that the possibility for double sale of land through the informal land access is very rare in Karu Urban Area. Hence, this attribute may not have any negative influence regarding housing delivery in Karu Urban Area. This goes contrary view to the findings of Adamu, (2014) which revealed that informal land access is susceptible to encouraging cutting corners thereby putting buyers at the risk of double payment or multiple ownership of land. The situation however is less pronounced in Karu Urban Area.

Relationship between Informal Access to Land and Housing Delivery (Chi-Square Test)

The outcomes of the respondents' opinions were tested to ascertain the validity of their claims through the chi-square test and the results shown in Table 2. The chi square calculated value of 206.164 which is greater than the chi square critical value 9.488 at 95 percent confidence interval and a significant value .000 ($p < 0.05$) posits that the null hypothesis is rejected while the alternative hypothesis is accepted and therefore indicates that informal access to land in Karu Urban Area has significant relationship with housing delivery.

Table 2: Test statistics

Chi-Square (χ^2_{calc})	206.164[a]
χ^2_{tab}	9.488
Df	4
Asymp. Sig.	.000

a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 70.6.

CONCLUSION AND RECOMMENDATIONS

This study concludes that informal access to land is significant in housing delivery in Karu urban area. More so, its advantage includes their ability to make land relatively affordable for housing. However, its disadvantages include potential for double sale of land, uncontrolled development of housing in the area and poor environmental conditions.

The following recommendations are therefore offered based on findings of the study:

i. It is recommended that tenure security should be improved to make land affordable, flexible in acquisition, reliable and available for housing development.

ii. Informal land access should not be completely disregarded as it has provided avenue for developers to develop their houses at their own pace as their capita enable them. Also, it contributes to housing delivery, this is because developers can easily acquire land, develop it and add to the national housing stock.

Since it has been established that there is positive relationship between informal access to land and housing delivery, land regularization (a strategy which aims to formalize lands which were previously under informal titles) should be adopted in formalizing lands in Karu in order to enhance title for properties, security of tenure, and freedom from eviction, and increased property value.

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Automatic Extraction of Farmland Boundary Lines from Satellite Imagery Using Fully Convolutional Networks – A Review

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Abstract:
Accurate information on agricultural field boundaries is important for precision agriculture and can serve as a basis for establishing cadastral information in countries which do not yet have. Though previous works have shown promising results in the delineation of agricultural field boundaries, automatic boundary extraction remains a significant task, especially in the case of smallholder farms in Africa. The field boundaries are often irregularly shaped and have a poor spectral contrast between internal and external parts of the fields. The internal parts of most smallholder farms are heterogeneous with mixed crops and trees. In this review, the applicability of a deep feature learning approach based on Fully Convolutional Networks(FCNs) for the detection of agricultural field boundaries was investigated.Boundary concept and the methods of boundary detection some of which include edge and contour detection, image segmentation, convolutional neural networks (CNN architecture), visual geometry group network (VGGNet), and fully convolutional network (FCN DKs) were also discussed, while also identifying some research issues associated with the implementation of FCN for boundary delineation. The study concludes by highlighting the advantages of adopting FCN over other methods of boundary delineation.

Keywords*: Fully Convolutional Networks, Convolutional Neural Network, Image Segmentation, Precision Agriculture, Cadastral Boundaries.*

INTRODUCTION

Boundary information have been captured on cadastral maps using existing image-based segmentation approaches such as edge detection methods, region-based methods and integrated methods for many centuries(Swetz, 2008). Field measurements with theodolites, total stations, and RTK GPS receivers are used in modern surveying, accompanied by calculations to assess the exact position of boundaries. However, particularly if the area to be surveyed is big, this process is tedious, time-consuming, and costly. Manual digitization is another common method for obtaining boundary information from aerial photographs and satellite images, this method is quicker than conducting direct field surveys, it is also time-consuming and subject to the operator's subjective judgment.

The availability of very high resolution (VHR) satellite images and unmanned aerial vehicle (UAV) images has made large-area surveys cheaper and quicker (Persello et al., 2019). VHR remote sensing data is still underutilized in Africa, especially in smallholding applications. Notwithstanding, it is difficult to extract boundary information from VHR remotely sensed images due to landscape. To address these issues, reliable, low-cost creative knowledge extraction methods are needed to assist farmers in these areas. To this end, in the last few years, there has been research on initiatives focusing on the use of VHR remote sensing technology in improving environmental quality. VHR remote sensing technology has improved crop production and, as a result, farmer livelihoods (Musyoka, 2018).

Agricultural boundary detection can be characterized as a classification problem in deep learning approaches like Convolutional Neural Networks (CNN), which involves the definition of classes with a higher level of semantic abstraction. Different orientations, scales, and spectral properties are taken into account when creating a boundary class (bare soil, stones, trees and vegetation). This is a difficult task that requires more than just spectral signatures to

distinguish between groups (Scott et al., 2017). Feature learning is a collection of techniques used in deep learning that allow a system to automatically find the representations needed for feature detection or classification from input data (Bengio et al., 2013).

Relevant Studies in Agricultural Boundary Detection

A deep feature learning approach based on Fully Convolutional Networks (FCNs) for the detection of agricultural field boundaries in Kofa region, located in Kano state in the northern part of Nigeria was investigated. The FCN architecture under investigation was tuned and equipped to detect apparent boundaries in VHR satellite imagery. The findings were compared to state-of-the-art methods such as globalized likelihood of a boundary (gPb) detection, e-Cognition multi-resolution segmentation, and the Canny detector. Apart from computational time and complexity, experimental findings indicate that the proposed approach outperforms the other approaches in all performance metricsThe FCNs were found to be capable of learning spatial-contextual features for accurate boundary class discrimination from a very complex dataset (Musyoka, 2018).

Xia et al. (2019) proposed a method for extracting cadastral boundaries based on deep Fully Convolutional Networks (FCNs), which automatically learn high-level spatial features from imagery. To create linked contours, the strategy combines FCNs with a grouping algorithm based on the Oriented Watershed Transform (OWT). The workflow of generating linked cadastral boundaries is the presentation of these contours hierarchically in an Ultrametric Contour Map (UCM) (FCN-OWT-UCM).

From very high-resolution satellite images, (Alemu.,2016) proposed a line segment detection (LSD) algorithm for delineating farm field boundaries and detecting crop rows. The accuracy of the method was determined by establishing two error ratios: one for missed detections and another for false detection of boundaries.The results were 0.78 and 0.73, respectively, and the researcher concluded that the errors were too high for realistic applications.

The delineation of farm parcels offers cadastral data that is useful in designing and managing climate change policies. Farm parcel delineation, in particular, tells land distribution, irrigation, fertilization, and greenhouse gas (GHG) policies in the downstream government. Using satellite imagery, (Aung et al., 2020) made farm parcel delineation easier.This was accomplished using two methods: parcel boundary segmentation and parcel field segmentation. U-Nets of various types were used, one of which took into account temporal information and generated the best results on a dataset of farm parcels in France in 2017.

Boundary concepts

In legal terms, a boundary can be defined as the outermost perimeter of lands that are recognized and formed. It's the imaginary line that separates two pieces of ground. (Duhaime, 2017). It can also be defined as a spatially referenced dividing object that separates adjacent land plots. (Crommelinck *et al.*, 2016).

RS-Based Methods of Boundary Detection

There are various methods of boundary detection, some of which are discussed as follows;

1. Edge and Contour detection

A discontinuity in grey-level, colour and texture in an image can be defined as an edge (Sonka *et al*., 1999). The term "contour detection" refers to the process of identifying the boundaries between segments or objects in an image. Search-based edge detectors (first-order derivative-

based edge detection methods) and zero-crossing based edge detectors are the two approaches to edge detection. Edges are detected using search-based methods in two steps by measuring the intensity gradient at a point in the image.The intensity of the edge is determined first by gradient magnitude, which is the sum of difference between pixels in the neighborhood, and then by gradient orientation, which is the direction of the greatest change. Due to its noise reduction capabilities, the Canny is one of the most spectacular search-based edge detectors. A Gaussian blur, which eliminates tiny texture artefacts, is used in Canny, a non-maximum suppression, which thins edges to make them more accurate, and a double threshold hysteresis, which classifies edges as weak or strong (Canny, 1986), with weak edges being discarded if they do not exceed the fixed threshold.

2. Image segmentation

In terms of spatial or spectral characteristics, segmentation is the method of separating images into spatially continuous, disjoint, and homogeneous areas (Blaschke et al., 2004). For various applications, a variety of image segmentation procedures have been proposed; however, only a few of these procedures produce quantitatively consistent results (Sourav et al., 2016; Kaur, 2015).The explanation for this is that the regions of concern in most cases are extremely heterogeneous. Pixel-based, edge-based, and region-based image segmentation methods are the three types of image segmentation methods (Blaschke et al., 2004). SegNet, or image segmentation network, is a deep convolutional encoder-decoder architecture.It is also considered a semantic segmentation model that has been shown to be effective in terms of memory and computational time (Badrinarayanan et al., 2017) The structure of SegNet is shown in Figure 1.

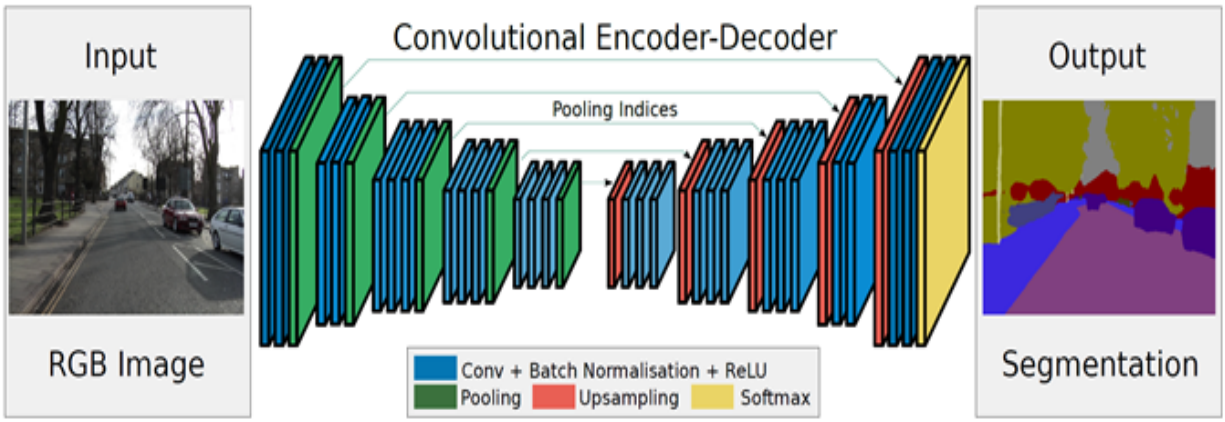

Figure 1: The architecture of SegNet (Badrinarayanan *et al.,* 2017)

3. Convolutional Neural Networks (CNNs or ConvNets)

One or more convolutional layers with learnable weights and prejudices make up ConvNets. In traditional architectures, feature maps are extracted using a series of convolutional layers, which are then flattened into a one-dimensional vector and fed to a fully-connected network (Goodfellow et al., 2015). The input to a convolutional layer is an image of dimensions $W \times W \times D$ where $W \times W$ is the height and width of the image and D is the number of channels. The convolutional layer is made up of K filters of size $F \times F$ where F is smaller than the dimensions of the image W. The filters are convoluted with the filters, resulting in feature maps that are equal to the number of filters (K). Each feature map is subsampled with average of

max pooling with a stride *s*, where the value of $s > 1$. With a stride of 1, subsampling yields feature maps that are identical to the input image. After the subsampling layers (pooling layers), each function is given a bias and non-linearity. Non-linearities, also known as activation functions, include Relu, Sigmoid, and Tanh, among others. Completely linked layers are added at the end of the networks in traditional CNN architectures.

CNN architectures

Bergado et al. (2016) proposed a CNN architecture for urban scene classification using high resolution aerial images in the remote sensing domain. Alshehhi et al. (2017) also proposed a single-patch CNN architecture for extracting roads and buildings from high-resolution satellite imagery. Mboga et al. (2017) also suggested a method for detecting informal settlements using VHR satellite imagery. After presenting CNN architecture with several training samples and a large number of convolutional layers, other state-of-the-art methods such as support vector machine (SVM) with radial basis function (RBF) kernel, the CNN architecture outperformed both SVM and RBF kernel. AlexNet (Krizhevsky et al., 2012), VGGNet (Simonyan and Zisserman, 2014), and LeNet, ZF Net, GoogLeNet, and ResNet are all common architectures in the literature (Li et al., 2017).

The AlexNet architecture created by Krizhevsky and colleagues is summarized in Table 1. (Krizhevsky et al. 2012).This design outperformed other models by a wide margin in the ImageNet Large Scale Visual Recognition Challenge (ILSVRC). Their top five errors were 16 percent, compared to 26 percent for the nearest model.

Table 1: Representation of AlexNet architecture.

Layer	Dimensions	Parameters			
		No. of filters	Filter dimensions	Stride	Pad
Input	227×227×3	-	-	-	-
CONV-1	55×55×96	96	11×11	4	0
Max pool 1	27×27×96	-	3×3	2	-
Noom 1	27×27×96	-	-	-	-
CONV-2	27×27×256	256	5×5	1	2
Max pool 2	13×13×256	-	3×3	2	-
Noom 2	13×13×256	-	-	-	-
CONV-3	13×13×384	384	3×3	1	1
CONV-4	13×13×384	384	3×3	1	1
CONV-5	13×13×256	256	3×3	1	1
Max pool 3	6×6×256	-	3×3	2	-
FC6	4096 neurons	-	-	-	-
FC7	4096 neurons	-	-	-	-
FC8	1000 neurons	-	-	-	-

4. Visual Geometry Group Network (VGGNet)

Simonyan and Zisserman (2014) demonstrated that the network's breadth is an important factor in a CNN's success. Increasing the depth of a network, on the other hand, is more costly because the number of parameters increases, requiring more memory space. Table 2 displays a sketch of the VGG16 architecture that was submitted to the ILSVRC in 2014.

Table 2: Representation of VGG16 architecture.

Layer	Dimensions	Parameters	
		No. of filters	**Filter dimensions**
Input	224×224×3	-	-
Conv 1-1	224×224×64	64	3×3×3
Conv 1-2	224×224×64	64	3×3×64
Max pool 1	112×112×64	-	-
Conv 2-1	112×112×128	128	3×3×64
Conv 2-2	112×112×128	128	3×3×128
Max pool 2	56×56×128	256	3×3×128
Conv 3-1	56×56×256	-	-
Conv 3-2	56×56×256	256	3×3×256
Conv 3-3	56×56×256	256	3×3×256
Max pool 3	28×28×256	-	-
Conv 4-1	28×28×512	512	3×3×256
Conv 4-2	28×28×512	512	3×3×512
Conv 4-3	28×28×512	512	3×3×512
Max pool 4	14×14×512	-	-
Conv 5-1	14×14×512	512	3×3×512
Conv 5-2	14×14×512	512	3×3×512
Conv 5-3	14×14×512	512	3×3×512
Max pool 5	1×1×512	-	
FC6	1×1×4096	-	-
FC7	1×1×4096	-	-
FC8	1×1×1000	-	-

5. Fully Convolutional Networks (FCN)

Traditional CNNs have completely connected layers with fixed dimensions, and one of their major drawbacks is that they discard spatial information. A CNN's output is a 1-dimensional distribution over classes (for Softmax regression), i.e. a single label prediction.A patch-based CNN works by extracting small patches or subsets of an image and then using a CNN model to predict the central pixel of each patch. The outputs are then organized in a 2-D layout using these labels (Fu et al., 2017). FCN-DKs are used to detect informal settlements in VHR files (Mboga et al., 2017).

FCN-DKs

In VHR pictures, Persello and Stein (2017) introduced a novel deep FCN for detecting informal settlements. Dilated kernels with increasing spatial support made up their proposed FCN. Using broad filters increases the number of parameters, which raises the cost of training the networks. However, a large number of parameters often decreases the networks' generalization capability.Dilated kernels (DKs), which increase spatial support without raising the number of memory parameters, were also proposed by Persello and Stein (2017) as a substitute for down-sampling. This increases the number of parameters that can be learned per layer without raising the computational cost. FCN-DKs are summarized in Table 3.

PERFORMANCE COMPARISON

The quality and reliability of the automatically extracted boundary lines will affect the performance of automatically extracted features. Precision and recall are two important metrics

for assessing the accuracy and consistency of boundary lines derived automatically. When an algorithm produces a high precision value, it means it has found more accurate boundaries in comparison to the total number of identified boundaries. In terms of precision, FCN-DKConv6 outperformed MRS, gPb, and Canny algorithms by 39.9% (Musyoka, 2018). As compared to other algorithms, a high recall value means that an algorithm has found more boundaries in the reference dataset, indicating a high level of completeness. A low recall value suggests a high number of false negatives, implying a low degree of completeness. With a recall of 38.26 percent, gPb outperformed the other algorithms (Musyoka. 2018).

Table 3: Summary of the FCN-DKs.

Layer	Module type	Dimension	Dilation	Stride	Pad
DK1	Convolution	5×5×8×16	1	1	2
	IReLU				
	Max-pool	5×5		1	2
	Convolution	5×5×16×32	2	1	4
DK2	IReLU				
	Max-pool	9×9		1	4
	Convolution	5×5×32×32	3	1	6
DK3	IReLU				
	Max-pool	13×13		1	6
	Convolution	5×5×32×32	4	1	8
DK4	IReLU				
	Max-pool	17×17		1	8
	Convolution	5×5×32×32	5	1	10
DK5	IReLU				
	Max-pool	21×21		1	10
	Convolution	5×5×32×32	6	1	12
DK6	IReLU				
	Max-pool	25×25		1	12
	Convolution	1×1×32×2	1	1	0
Class	Softmax				

The F-score, which is described as a combination of precision and recall, is a more accurate overall measure of quality results. FCN-DKConv6 had the highest F-score of all the algorithms studied, indicating that it was superior in terms of both exactness and completeness (Musyoka, 2018).

Xia et al. (2019) measured the efficiency of the average score from two research tiles based on accuracy, recall, and F-score in order to obtain an unbiased evaluation. With 33.12 percent and 30.77 percent, respectively, FCN-OWT-UCM had the highest F-score in both testing tiles, followed by FCN with 30.08 percent and 33.12 percent. gPb-OWT-UCM and MRS took the third and fourth place in the first tile, whereas in the second tile, their ranking was reversed. In both tiles, FCN outperformed other algorithms in terms of precision. The highest recall was achieved by gPb-OWT-UCM in the first tile and MRS in the second tile. However, in terms of accuracy, these two algorithms performed poorly. The best overall result was achieved by FCN-OWT-UCM, which had a reasonably balanced precision and recall.

Why is FCN better than CNN?

As compared to CNNs, the experimental results showed that FCN performed better in terms of prediction of any pixel of an output map, according to Fu et al. (2017) and Persello& Stein

(2017). A downsample-then-upsample scheme is used to implement this prediction procedure (Persello& Stein, 2017).Long et al. (2015) suggested an FCN model for replacing completely connected layers in a CNN with convolutional layers, demonstrating this. The proposed FCN model can be trained to predict all of the pixels in an image or patch, ensuring that the 2-D structure is preserved.Unlike the CNN, which predicts the label of the central pixel, a patchwise trained FCN predicts the labels of all the pixels in the entire patch. In comparison to CNN, FCN has proven to be simple to implement since it can train an entire image at once and is computationally inexpensive.Since CNNs predict a pixel's label per patch, further computations are needed to predict the labels of all pixels in a patch and the entire image.

OBTAINING CONNECTED BOUNDARY

FCN is equipped to differentiate between cadastral boundaries and other visible image features on the UAV data set using binary classification. After this stage, you'll have fragmented boundaries. The Oriented Watershed Transform (OWT) is then applied to the output feature map to link disjoint boundaries (Arbeláez et al., 2011).FCN's output function map is a probability map that depicts the likelihood of each pixel being a boundary. The chance map can be transformed into regions and arcs using the watershed transform (WT). These arcs represent possible boundary positions, and the intensity of each arc's boundary is determined by the average likelihood of all pixels on the arc.Each pixel's probability of becoming a boundary varies depending on its orientation, and the highest probability is eventually allocated to each pixel because its boundary intensity presents a significant challenge. As a result, some weak arcs could be influenced by strong arcs nearby and end up with high intensity, since those intersecting pixels had the highest probability.By measuring the likelihood of each pixel at the arc's orientation, OWT was able to solve the problem. As a result, the up-weighted arcs could be set.OWT supplies a set of closed regions surrounded by arcs with finest partition. A hierarchy of these regions can be built by the Ultrametric Contour Map (UCM) (Arbeláez *et al.*, 2011).

OWT-UCM is a computer vision algorithm that creates hierarchical regions out of segmented contours (Arbeláez et al., 2011).

Raster line work offers largely full field boundaries, although there are some gaps. Before creating a GIS layer with closed polygon topology specifying fields, it's important to fill in these gaps and remove any unnecessary "dangles" (lines that do not connect at both ends). (North *et al*., 2019).

The globalized probability of a boundary (gPb) is calculated by linearly integrating the multiscale probability of a boundary (mPb) and the Spectral probability of a boundary (sPb). These two methods were derived from the original likelihood of a boundary (Pb) method, which uses an oriented gradient signal to determine the intensity of a contour across a series of pixels (Martin et al., 2004). The probability of a boundary (Pb) is then generalized to the multiscale probability of a boundary (mPb), which performs boundary probabilities using four different channels (intensity, color a, color b, and textons) and eight different orientations. The texture channel (texton) is created by using 17 Gaussian derivative filters to convolve the input image. The pixels are gathered using K-means clustering.The resulting cluster assignments take the place of pixel intensity information to create a new image known as a texton image, which displays the strongest edges (Musyoka., 2018).

Identified research issues associated with FCN

From the review, it was discovered that most research on FCN focuses on automatic feature detection techniques for cadastral boundary mapping, post-processing procedure for integrating the technique in real practices were not discussed. Boundary classification is a binary classification task with highly imbalanced classes, the amount of boundary pixels is much less than non-boundaries. Evidences suggesting that FCN has been integrated with oriented watershed transform and ultrametric contour maps which can produce closed contours are not also available in the reviewed literature. It was also observed that the performance of FCN has mostly been investigated with images that has good spatial resolution but not with open-source satellite images. Finally, FCN is a fully supervised algorithm, and the training and updating of the network rely on large number of labelled images, which requires extensive manual labelling work. This requirement limits the application of this method.

In order to address some of these identified issues, Xia, (2019) proposed designing a contextualized workflow for post-processing to better embed the automation result into cadastral mapping procedure in order to discuss post-processing procedure for integrating the technique of automatic feature detection for cadastral boundary mapping. Xia, (2019) also proposed allotting more weights to boundary class through the use of weighted loss function in FCNs so as to improve the classification accuracy. Integration of FCN with oriented watershed transform and ultrametric contour maps was proposed by Musyoka (2018) in order to produce close contours. Other recommendations include investigation of the performance of the proposed FCN using other coarser resolution, open-source satellite images like sentinel-1 and sentinel-2 and investigation of techniques for improving accuracy, like integrating the FCN with classifiers capable of noise reduction like CRF. Huang *et al.*(2018) proposed introducing weak-supervised learning and unsupervised learning algorithm so as to reduce the manual labelling work and enhance the ease of application of the FCN algorithm.

CONCLUSIONS

Boundaries of agricultural fields are important features necessary for defining the location, shape and spatial extent of agricultural units. This review has been able to provide concise information on boundary concepts, methods and algorithms used for automatic boundary delineation. It has also provided justification on why FCN is best used for the automatic extraction of farmland boundary lines if optimal results is required. Further research will attempt to practically implement FCN for the automatic extraction of farmland boundary lines using Sentinel imageries.

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Prospectivity Mapping for Gold (Au) Mineralization Using LandSAT 8 OLI Data in Part of Niger State, Nigeria

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Abstract
The study was designed for possible precursor of gold (Au) mineralization in Rafi Local Government Area of Niger state and its environs. Remote sensing (RS) technique was adopted as means for delineating hydrothermal alteration zones for probable precursor of Au mineralization. The study utilised five spectral bands from LandSAT 8 OLI satellite image to compute Sabin's ratio and Kaufmann's ratio within the study area. Based on the computed ratios, the results confirmed the findings that remote sensing studies could be used for demarcation of hydrothermal alteration. It was therefore concluded that integration of remote sensing techniques (using the adopted ratios) and geological field mapping provide a tool for delineating economic mineralization of Au.

Keywords: Hydrothermal alteration zone, Mineralization zone, Band ratioing

1.0 INTRODUCTION

Mineral prospecting and several other mining activities are an important source of national income in most developing countries; with prospectors constantly in search for fast and cheap techniques that can aid the task (Aminzadeh and Samani, 2006). Usually, mineral exploration is capital intensive, and as such, prospectors are often not willing to invest until the presence and quantity of mineralization is empirically ascertained. The uncertainty of the presence and quantity of Gold (Au) minerals in Rafi Local Government Area of Niger state has led to the nefarious activities by illegal miners within the area. Such illegal mining works have continued to increase the rate of environmental degradation and loss of minerals (Sadiya *et al.*, 2014).

Conventional methods for mineral prospecting are costly and time consuming, therefore necessitating the utilization of a faster and cost-effective method. Remote Sensing (RS) has since been utilized as a fast, cost effective and very reliable tool for geologic mapping and mineral exploration (Goetz *et al.*, 1983). Since the initial stage of RS technology, RS images are applied to mineral exploration in either mapping of geological features, such as fractures and faults, which host ore deposits; and mapping hydrothermal alteration minerals using their spectral features (Sabins, 1999). Discrimination of hydrothermal alteration assemblages and their distribution is an important part in exploration of hydrothermal ore deposits and generation of the most appropriate ore deposit model (Thompson *et al.*, 1999). In this study, RS data would be used to delineate hydrothermal alteration zones within Rafi LGA, with a view to identification of possible gold deposits within the study area.

Despite several research efforts on the global scene where RS is used for lithology mapping, much has not been done in utilizing RS for identification of mineral deposits in Nigeria. Besides, many of the previous studies have been limited to the use of LandSAT 7 ETM; and only few studies have explored the potentials of the LandSAT 8 OLI mission. The aim of this

paper is to examine the potentials of the LandSAT 8 OLI for Au mineralization mapping within the study area.

2.0 Spectral Characteristics of tailings from an Hydrothermal Gold mine

Arsenic (As) and lead (Pb) are the commonest toxic wastes that are generated as pollutants on the environment from hydrothermal Gold (Au) mines, with Pb being the most prominent especially where crude methods of gold exploration and refining is adopted (Alloway, 2013; Jeong *et al*, 2018). In Nigeria, Pb has been identified as the leading tailing from Au exploration and mine sites (Nabulo *et al.*, 2012). The reflectance value (R) of these tailings when subjected to the electromagnetic (EM) spectrum depends only on the complex refractive index (n) and the damping constant (k), as shown in Equation (1)

$$R = \frac{(n-1)^2+K^2}{(n+1)^2+K^2} \quad (1)$$

Spectroscopic analysis of Lead (Pb) by previous studies have shown that the Visible Near Infrared (VNIR) to Shortwave Infrared (SWIR) (i.e VNIR - SWIR) spectral ranges of 350 to 2500 nm are very useful in the study of the physicochemical properties of Pb and Au (Thompson *et al.*, 1999; Sun *et al.*, 2001; Asmaryan *et al.*, 2013, Pour and Hashim, 2014). Consequently, the following bands within the LandSAT 7 ETM and LandSAT 8 OLI satellite images are suitable for Au mineralization prospecting and also Pb contamination detection;

Table1: Satellite image bands useful for Gold mineral prospecting

Satelite Mission	Band	Reflectance	wavelength (μm)
LandSAT 7 ETM	2	Green	0.52 - 0.60
	3	Red	0.63 - 0.69
	4	NIR	0.77 - 0.90
	5	SWIR	1.55 - 1.75
LandSAT 8 OLI	2	Blue	0.452 - 0.512
	3	Green	0.533 - 0.590
	4	Red	0.636 - 0.673
	5	NIR	0.851 - 0.879
	6	SWIR	1.567 - 1.651
	7	SWIR	2.107 - 2.294

3.0 Materials and Methods

In this study, RS technique has been adopted as means for delineating hydrothermal alteration zones, with intention to use such zones as possible precursor of Au mineralization. Hydrothermal alteration refers to the process which alters the mineralogy and chemistry of the host rocks, resulting in producing mineral assemblages which vary according to their location, degree and duration of the alteration process (Mila and Fijamitsu, 2012).

3.1 Materials

The following materials were used for the study:

(a) LandSAT 8 OLI satellite image for path 190 and row 52, covering the study area and acquired on the 8th of April, 2019. The data was obtained from the Global Land Cover Facility (GLCF) of the University of Maryland. The LandSAT 8 OLI image has 9 spectral bands: 4 in the Visible (VIS) (0.43–0.67 mm), 1band of the Near Infrared (NIR) (0.85–0.88 mm), 2 bands of the Shortwave Infrared (SWIR) (1.57–2.29 mm), 1band of cirrus (1.36–1.38 mm) and a final band in the Panchromatic band (0.50–0.68 mm). The first 8bands have spatial resolution of 30m while the panchromatic band has a resolution of 15m. The Panchromatic band is usually used to resample the other bands to 15m. As earlier discussed in section 2.0, out of these 9 bands, only 5 bands (3, 4, 5, 6, 7) were used in this study. Selection of the date of image acquisition was carefully considered to ensure "cloud-free" and "water-free" images.
(b) Geological samples collected during the field work from the study area. These include; 10 chip samples for Au analysis and 20 alluvium samples subjected to atomic absorption Spectometric (AAS) test and analysis. The Geological samples were used for validation of the RS analysis, in order to confirm the presence of Au mineralization in the RS identified regions.

3.2 Methods

The study was conducted using the following RS techniques in the sequence specified below:
3.2.1 Colour Composite (CC): Colour composites are various colour combinations that are done to enhance specific features in an image. A natural or true colour composite (TCC) is an image displaying a combination of the visible red, green and blue bands to the corresponding red, green and blue channels on the computer display. A TCC shows all features of an image in their true and natural colours. In most cases, due to spatial resolution, it is often very difficult to discriminate most features in TCC, hence a false colour composite imposed to aid visual discrimination. False colour composites (FCC) allow us to visualize the wavelengths the human eye does not see (near the infrared range). False colour images are a representation of a multispectral image created using ranges other than visible red, green and blue (RGB) components
3.2.2 Band Ratio (BR): Based on the spectral reflectance curve for hydrothermally altered rocks, BR is used to emphasize possible anomaly within the target thus leading to the identification of the specific mineral features (San *et al.*, 2004; Nouri *et al.*, 2012). Furthermore, BR reduces the effect of topography, hence enhancing the difference between spectral responses of each band. The BRs and red–green–blue (RGB) color composite (CC) created with the Landsat 8 OLI images serve as basis for mineral detection (Mars and Rowan, 2010). The BR was executed as depicted in Table 2;

Table 2: A serial arrangement of the Band Ratio used for Au Mineralization prospecting

CC	BR	Interpretation		Reference
		Color	**Mineral depicted**	
TCC	4,3,2	Green	Vegetation	Welch, 1987; Han and Nelson, 2015
		Brown	Soil / Rock outcrops	
		Blue	Water	
FCC	5,6,7	Light blue	Outcrop	Zoheir, 2012
		Black	Water	
		Orange	Vegetated Areas	
Boolean	4/2	Bright tone	Iron-oxide: Showing evidence of oxidation this tending towards hydrothermal alteration	Zoheir, 2012
Boolean	6/7	Bright tone	Allunite and hydrothermal clay i.e hydroxl bearing rocks. Further showing evidence of hydrothermal alteration	Han and Nelson, 2015
Boolean	7/5	Bright tone	clay minerals (illite, kaolinite and montmorillonite). More evidence of hydrothermal alteration	Han and Nelson, 2015
Boolean	6/5	Bright tone	Ferrous minerals. Also serving as evidence of hydrothermal alteration	Mwaniki et al., 2015
Sabin's ratio	(4/2, 6/7, 6/5)	Light green	Altered rocks	Sabins, 1999
		Light blue-yellow	Outcrop	
Kaufmann's ratio	(7/5, 5/4, 6/7)	Red	Could be Hydrothermal alteration	Mila and Fujimitsu, 2012
		Dark green	Meta sediments	

3.3 Study Area

The study was conducted over Niger state with emphasis on mining areas around Mokwa and Madaka districts (Figure 1) and their environs. The major communities around Madaka district are Shika, Angwan Magiro and Angwan Kawo communities. Shikira is situated on the eastern flanks of Kagara town, the headquarters of Rafi Local Government Area of Niger State, Nigeria. The selected sites were chosen based on the artisanal mining activities on going in the locations. The people are predominately farmers while some are nomads. Mining activities have been going on in Madaka district for years and this involves both the indigenes and foreigners. Consequently, there are shallow pits and furrows, where some gold-bearing stones, called quartz, were extracted although later abandoned due to low yield. The gold prospectors then moved on to new minefields, which abound in the area thereby exposing people in the area to heavy metal pollution (Ikhumetse *et al.*, 2019)

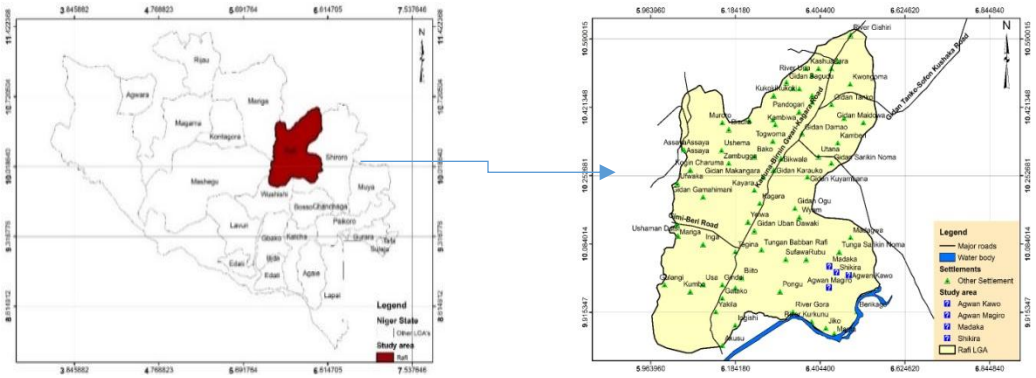


Figure 1: Map showing Niger state (with Rafi LGA highlighted in red) on the left and an enlarged view of Rafi LGA indicating Madaka district on the right.
Source: Department of Geography, FUT, Minna.

3.3.1 Geology of the Study Area

About half of the landmass of Niger State is underlain by the Basement Complex rocks while the remaining half is occupied by the Cretaceous Sedimentary rocks of the Bida Basin (Figure 2). It lies within the north-central portion of the Nigerian Basement complex rock which is characterized by three lithofacies namely; the migmatite-gneiss complex, the low-grade schist belt and the older granites (Olasehinde, 1999). The geological mapping revealed that the area is underlain by granite and gneiss which in most locations are undifferentiated granite-gneiss-complex.

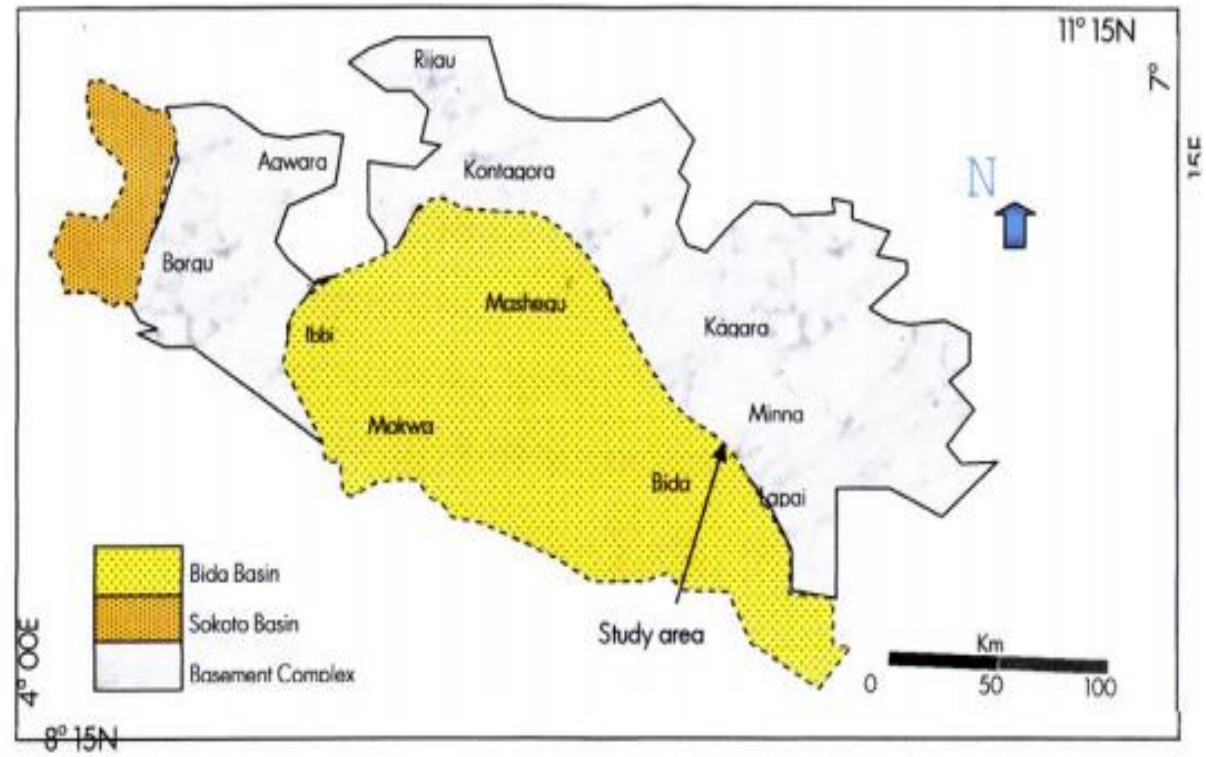


Figure 2: Geology of Niger state (Amadi *et al.*, 2012).

4.0 RESULTS AND DISCUSSION

The results obtained from the colour composites and band ratios are presented and discussed below;

4.1 Colour Composites:

The TCC and FCC were generated based on the band combinations identified in table 2. The result obtained tally with the expected colour output as specified in table 2 i.e the results obtained from the TCC and FCC conform with known features as seen within the study area (Figure 3a and b).

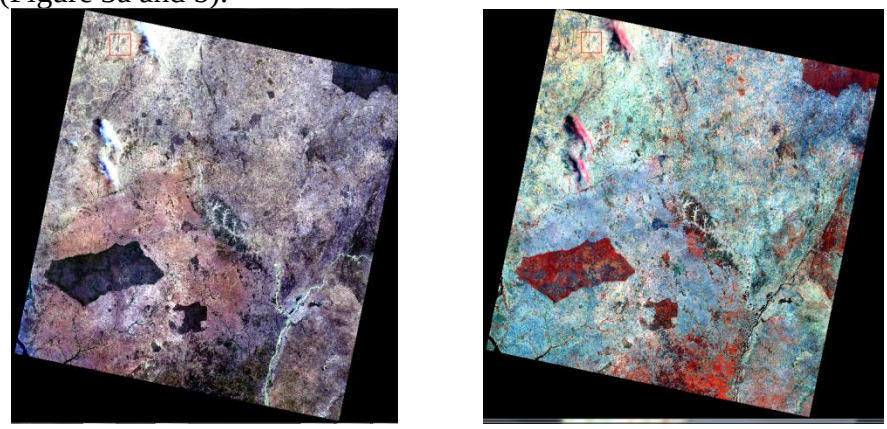
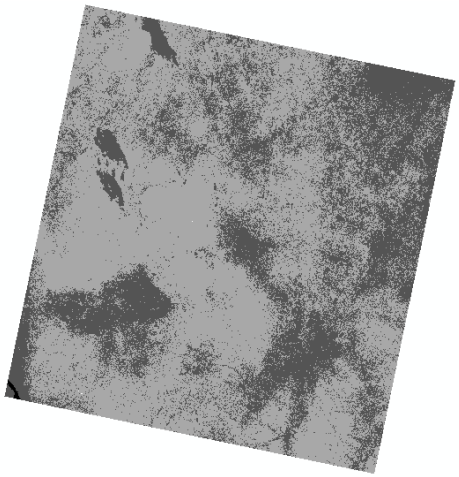


Figure 3(a) True colour composite (b) False colour composite

As identified in table 2, the areas shown in light blue colour in the FCC correspond to rock outcrops. Also, the large rectangular opening shown as bare soil in the TCC and also light blue in the FCC indicates open cast mine area where mining activities is on-going.

4.2 Band Ratios:

The band ratios were also performed to further identify possible hydrothermal alteration zones within the study area as a precursor Au mineralization prospecting. Images enhancing hydrothermal altered rocks using band ratios with distinctive reflection features were produced. This corresponds directly to minerals associated with this alteration and represents surface expression for Gold (Au) deposits. Thus, it was applied the ratio of Landsat 8 OLI band 4 over band 2, to highlight areas with abundant iron oxides bearing minerals, as brighter pixels (Figure 4 (a)). Ratio of Band 6 over band 5 discriminate ferrous minerals in bright tone (Figure 4 (b)). Clay minerals, as illite, kaolinite, and montmorillonite are discriminated with the ratio image of band 7 over band 5 as bright pixels (Figure 4 (c)). The ratio image of band 6 over band 7 distinguish altered rocks containing clays and alunite from unaltered rocks, where pixels are bright (Figure 4 (d)).



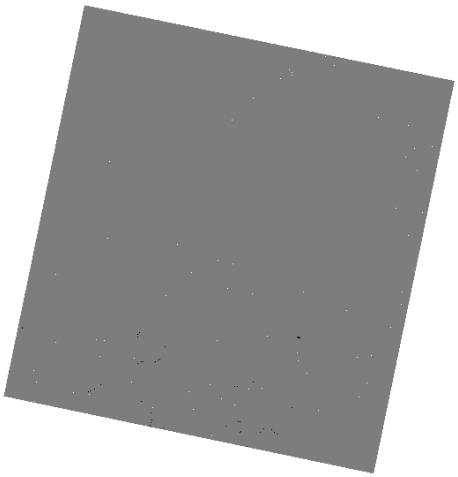
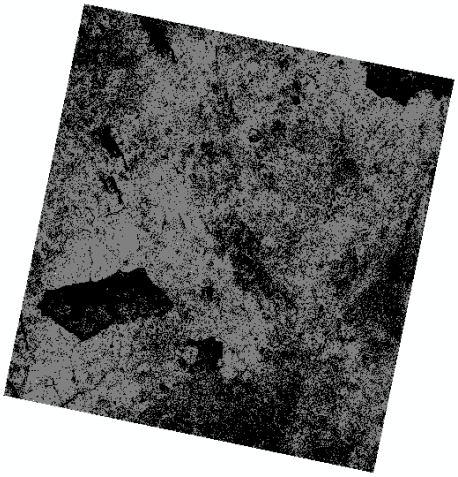
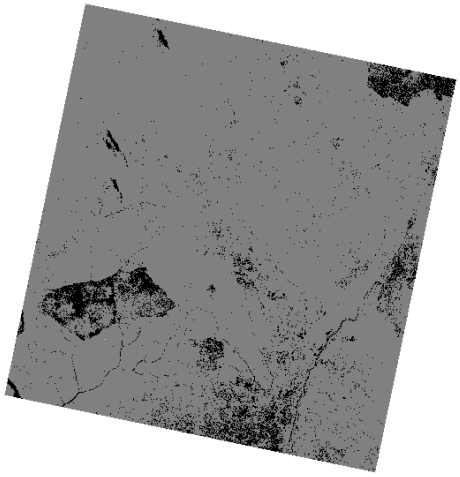


Figure 4(a) Iron-oxide minerals (BR = 4/2) **(b) Hydroxl-bearing rocks (BR = 6/7)**





(c) Clay minerals (BR = 7/5) **(d) Ferrous minerals (BR = 6/5)**

Looking at the result from the BR's, it is obvious that the study area is actually rich in Iron-oxide, clay and ferrous minerals. There are also scanty deposits of hydroxyl bearing rocks around the study area. In order to aid conclusion of possible hydrothermal alteration zones and likely Au mineralization deposits, the Sabin's and Kaufmann's ratios were computed as presented in Figures 5a and b respectively.

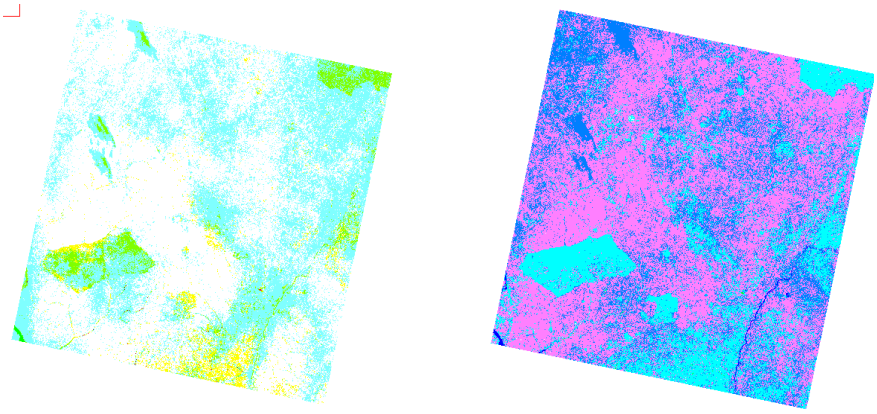


Figure 5(a): Sabin's ratio (b) Kaufmann's ratio

As shown by the Sabin's ration, about 20% of the study area shows spectral reflectance values that corresponds to the presence of altered rocks. This is further validated by most of such identified areas appearing as dark green in the Kaufmann's ration which confirms presence of metal sediments (Githenya *et al*., 2021). These RS observed values are validated by the Atomic Absorption Spectrophotometry (AAS) test conducted on the geologic samples taken from the site. The results of the AAS test and RS investigation as well as on-going mining activities within the study area confirm the presence of Au mineralization in suitable quantity.

5.0 Conclusion:

The study confirms the ability of RS techniques (especially the use of colour composites and band ratioing) to effectively map Au mineralization within a given area. Furthermore, the study confirms the capacity of LandSAT 8 OLI for Au mineralization prospecting. It is recommended that further geophysical investigations should be conducted to further ascertain the location and quantity of Au mineralization within the study area. It is also recommended that further study should be carried out to ascertain the possibility of using RS for mineral quantification.

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Assessment of Geothermal Potential Within the Basement Region of Kogi State, Using Aeromagnetic Data

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Abstract:

Interpretation of Total Magnetic Intensity for Geothermal potential within the Basement Region of Kogi State was executed by the analysis and interpretation of aeromagnetic data of the area. Spectral depth analysis was employed to unravel the geothermal parameters corresponding to Curie point depth, Geothermal gradient and Heat flow of study area. The analysis showed a distribution of heat flow values ranging from 60 to 166 mW/m^2 across the study area with an associated geothermal gradient range of 24 to 66 °C/km. Both Heat flow and geothermal gradient maximum values were recorded at the eastern edge of Lokoja, mid-portion of study area (Longitude 6.125 °E and Latitude 7.75 °N). The least Curie point depth of 8 km also occurred at this point making it the most favourable for exploration of geothermal energy in the study area.
Keywords: *Curie point depth, Geothermal gradient, Heat Flow*

INTRODUCTION

Geothermal energy is the heat produced deep in the Earth's core. It is a clean, renewable resource that can be harnessed for generation of electricity and other industrial heating requirements. The vast majority of Earth's heat is constantly generated by the decay of radioactive isotopes, such as potassium, thorium and Uranium. Radioactive decay is a continual process in the core and the heat generated from the core constantly radiates outward warming rocks, water, gas, and other geological material. As earth's temperature rises with depth from the surface to the core, the gradual change in temperature is known as the Geothermal Gradient. Measurements have shown that a region with significant geothermal energy is characterised by an anomalous high temperature gradient and heat flow (Tselentis *et al*., 1991). The depth to bottom of magnetic sources or Curie point depth is known as the depth at which the dominant magnetic mineral in the crust passes from a ferromagnetic state to a paramagnetic state under the effect of increasing temperature (where magnetisation is lost) (Nagata, 1961). It is therefore expected that geothermally active areas would be associated with shallow Curie point depth (Nuri *et al*., 2005).

The generation and distribution of stable electrical energy is valuable component in national development. This study aims at highlighting the geothermal energy resource of study area which information is essential for siting a geothermal power plant for electricity generation.

LOCATION OF STUDY AREA

The study area is part of the confluence region denoting the region where river Benue and river Niger coincide. It is situated at the left hand side of the river Niger cutting across Koton-Karfi, Lokoja down to Idah. It is bounded by Latitude 7.0°N to 8.5°N and Longitude 6.5°E to 7.0°E.

GEOLOGY OF STUDY AREA

The geological setting of Kogi State is unique in view of the occurrence of the two major components of Nigerian geology (Basement Complex and Sedimentary Basin). Approximately, half of the State is covered by crystalline Basement Complex while the other half is covered by Cretaceous to Recent sediments.

The Basement Complex are predominantly underlain the western flank of the State. They are made up of Migmatite-Gneiss Complex which include rocks of migmatites, gneisses and granite-gneisses; the Schist Belts (metasedimentary and metavolcanic rocks) which include phylites, schists, pelites, quartzites, marbles and amphibolites; and the Pan-African Older Granites consisting of granites, granodiorites, syenites, monzonites, gabbro and charnockites. The crystalline complex contained economic minerals such as iron ore, gemstones, quartz, feldspar and other associated minerals, while the Pan-African Older Granite contained cassiterite, tantalite, columbite, gemstones and other associated minerals (Kogi State Ministry of Solid Minerals Development, KSMSMD, 2004). Figure 1 shows a draft of this geology specific to study area.

THEORY OF METHOD

The mathematical models of the centroid method are based on the examination of the shape of isolated magnetic anomalies introduced by Bhattacharyya and Leu (1975, 1977) and the study of the statistical properties of magnetic ensembles by Spector and Grant (1970). Blakely (1995) subsequently introduced power spectral density of total magnetic field, $\phi\Delta T(k_x, k_y)$ as:

$$\phi\Delta T(k_x, k_y) = \phi_M(k_x, k_y).4\pi^2 {C_M}^2 |\Theta_M|^2 |\Theta_f|^2 e^{-2|k|Z_t}\left(1 - e^{-2|k|(Z_b - Z_t)}\right)^2 \quad (1)$$

where k_x and k_y are wave numbers in x and y direction, $\phi_M(k_x, k_y)$ is the power spectra of the magnetization, C_M is a constant, Θ_M and Θ_f are factors for magnetization direction and geomagnetic field direction, and Z_b and Z_t are depths to bottom and top of magnetic layer respectively.

If the layer's magnetization, $M(x, y)$ is a random function of x, y it implies that $\phi_M(k_x, k_y)$ is a constant, and therefore the azimuthally averaged power spectrum, $\phi(|k|)$ would be given as

$$\phi(|k|) = Ae^{-2|k|Z_t}\left(1 - e^{-2|k|(Z_b - Z_t)}\right)^2 \quad (2)$$

The depth to the top of the magnetic source is therefore derived from the slope of the high-wave-number portion of the power spectrum as:

$$\ln\left(P\left((k)^{\frac{1}{2}}\right)\right) = A - |k|Z_t \quad (3)$$

where $P(k)$ is the azimuthally averaged power spectrum, k is the wave number ($2\boldsymbol{\pi}\ \boldsymbol{k}m^{-1}$), A is a constant, and Z_t is the depth to the top of magnetic sources.

The centroid depth of magnetic sources can also be calculated from the low-wave-number portion of the wavenumber- scaled power spectrum as (Tanaka *et al*., 1999)

$$\ln\left(P\left((k)^{\frac{1}{2}}/k\right)\right) = B - |k|Z_0 \quad (4)$$

where B is a constant and Zo is the centroid depth of magnetic sources.

The depth to the bottom of the magnetic source (Z_b) can subsequently be obtained from the relation (Okubo *et al*., 1985)

$$Z_b = 2Z_0 - Z_t \quad (5)$$

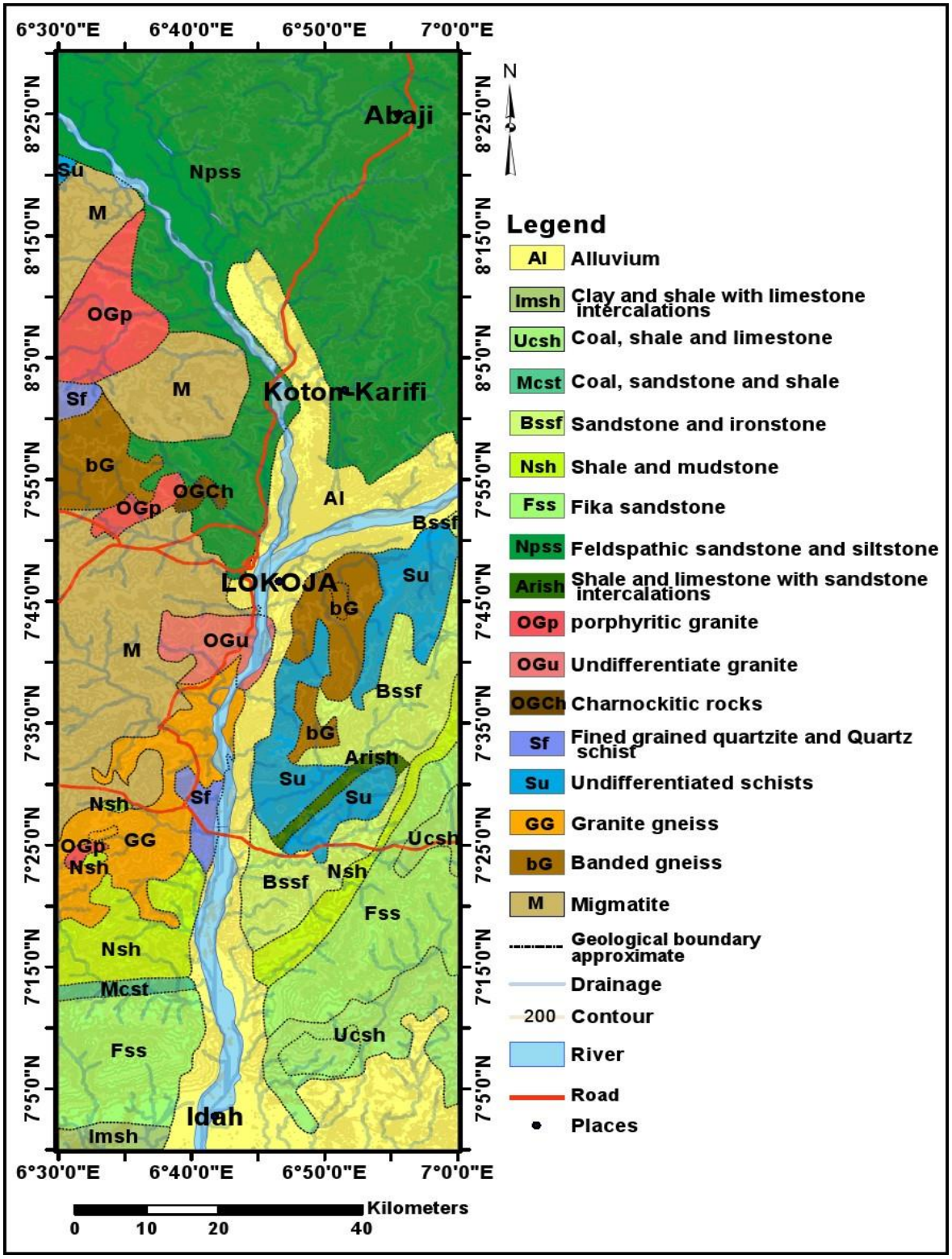

Figure 1 Geology Map of Study Area (modified from NGSA, 2009)

Using the depth to the bottom of magnetic sources (Z_b), the geothermal gradient $\left(\frac{dT}{dZ}\right)$can be estimated as (Tanaka *et al*., 1999; Ross *et al*., 2006)

$$\left(\frac{dT}{dZ}\right) = \left(\frac{\Theta_c}{Z_b}\right), \quad (6)$$

where Θ_c is the Curie temperature.

Next, using Z_b and $\frac{dT}{dZ}$, the heat flow (q_z) can similarly be estimated as (Okubo *et al*., 1985)

$$q_z = -\sigma\left(\frac{\Theta_c}{Z_b}\right) = -\sigma\left(\frac{dT}{dZ}\right), \quad (7)$$

where σ is thermal Conductivity. Thermal conductivity of 2.5W/m/°C as the average for igneous rocks and a Curie temperature of 580 °C (Stacey, 1977; Trifonova *et al*., 2009) are used as standard.

DATA SOURCE

The study area comprising of Sheet 227 (Koton-Karfe), 247 (Lokoja) and 267 (Idah) dataset were obtained from the Nigeria Geological Survey Agency (NGSA) with the parameters and specification shown in Table 1.

Table 1: Data Parameter and Specifications (NGSA, 2010)

Survey Parameter	**Parameter Specification**
Data Acquired by:	Fugro Airborne Surveys
Time Range	2005 – 2009
Magnetic data Recording Interval	0.1 seconds or less
Sensor Mean Terrain Clearance	80 meters
Flight Line Spacing	500 meters
Tie Line Spacing	5000 meters
Flight Line trend	135 degrees
Tie Line trend	45 degrees
Equipment: Aircraft	Cessna Caravan 208B ZS-FSA, Cessna Caravan 208 ZS-MSJ,
Equipment: Magnetometer	3 x Scintrex CS3 Cesium Vapour

METHOD AND ANALYSIS

In order to access the temperature parameters (Curie Point Depth, Heat Flow and Geothermal Gradient) of the study area, the Aeromagnetic data was subjected to spectral depth analysis sequences:

- The TMI was windowed into eight overlapping windows or sub-sheets.
- Each section of the windows was subjected to Fast Fourier Transform (FFT) and subsequently spectral depth analysis, a process which decomposes the anomalies into its energy and wave number components.
- A plot involving Energy versus wave number in cycle/km was made
- The energy versus wave number plot in a Mat Lab software generated Gradients that were used to estimate depth to the top, depth to bottom, Centroid depth, geothermal gradient and Heat flow of study area.
- A contouring software (surfer version 15) was used to generate contours maps for which indicates distribution of Curie point depth, Geothermal gradient and Heat flow of study area.

RESULTS AND DISCUSSIONS

Spectral depth analysis was applied to the aeromagnetic data with the aim of determining the depth to basement as well as the basement morphology. The data processing generated results summarised in Table 2. Contour maps were generated to show the distribution of the temperature parameters. The depth to magnetic sources at shallow depth (Z_T) occurred between 0.185 and 0.336 kilometres while centroid depth varied from 4.46 to 12.09 km. (Table 2)

A record of Curie depth (Z_B) across the study area (Figure 2A) varied from 8.69 to 23.98 km with and average value of 16.45 km. peak to medium CPD values were recorded at Idah (southern part) and Koton-Karfe (norther part) respectively. Low CPD values of study area were recorded at the Lokoja (Middle region) area with the least value occurring at the eastern edge of Lokoja

Figure 2B shows distribution of geothermal gradient across the study area. The Koton-Karfe area (North) and Idah area (southern part) shows low values ranging from 24 to 34 °C/Km. The middle portion (Lokoja area) shows prevalence of high values with highest value occurring at the eastern edge of Lokoja area.

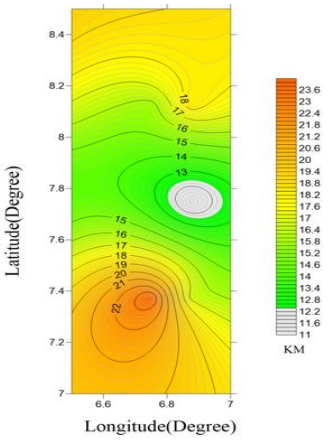

Figure 2A: Curie point depth of study area

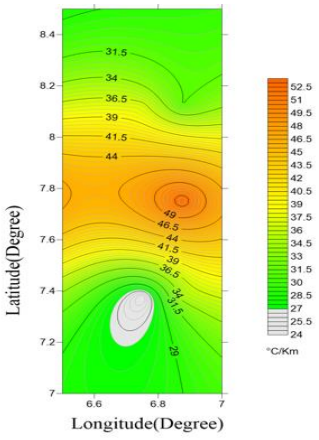

Figure 2B: Geothermal gradient of study area

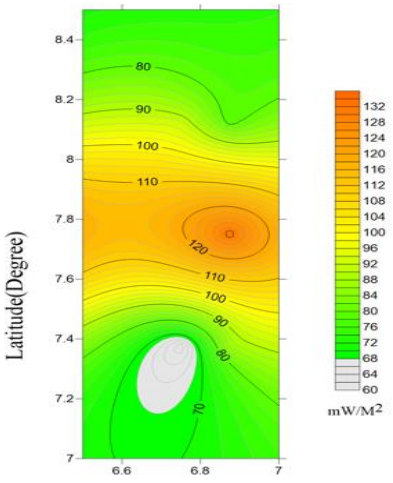

Figure 2C: Heat Flow of study area

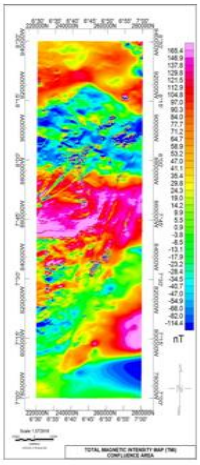

Figure 2D: Total Magnetic Intensity map of study area

An anomalous Heat flow of range 100 to 166 mW/m^2 was recorded across the middle portion of study area trending E-W of Lokoja region while values between 60 to 90 mW/m^2 is shaded in green colour at the upper and lower regions of study area (Figure 2C).

Table 2: Estimated values of the Curie Point Depth, Geothermal Gradient and Heat Flow

Section	Lon (°E)	Lat (°N)	Grad (G1)	Depth to Top Z_T (Km)	Grad (G2)	Depth to Centriod Z_0 (Km)	Curie Point Depth Z_B(Km)	Geothermal Gradient (°C/Km)	Heat Flow (mW/M^2)
1	6.125	8.125	135	0.25222788	3.17	10.74156588	21.23090388	27.31866732	68.29666829
2	6.875	8.125	117	0.18539147	2.33	9.309357097	18.43332272	31.4647559	78.66188976
3	6.125	7.375	102	0.336569064	4.23	8.115849777	15.89513049	36.48916254	91.22290634
4	6.875	7.375	107	0.303150859	3.81	8.513685551	16.72422024	34.68024169	86.70060422
5	6.75	8.125	99.9	0.229153405	2.88	7.948758752	15.6683641	37.01726589	92.54316474
6	6.75	7.375	152	0.20050923	2.52	12.09420751	23.98790579	24.178851	60.4471275
7	6.125	7.75	56.1	0.23154042	2.91	4.463717377	8.695894335	66.69814256	166.7453564
8	6.875	7.75	70.6	0.210057288	2.64	5.61744112	11.02482495	52.60854503	131.5213626

CONCLUSIONS

The entire middle portion of study area shows trends of viable geothermal parameters (Curie point depth, Geothermal gradient and Heat flow) making it the most prospective for exploring geothermal energy. The middle portion of study area is also associated with high magnetic susceptibility values as can be seen on the TMI map (Figure 2D) a feature that is influenced by the basement geological make-up of the area which hosts rock types such as Banded Gneiss, Migmatite, undifferentiated schist and granite. (Aydın & Oksum, 2010) inferred that Curie point temperature varies from area to area depending on the geology and rock mineral contents and it is therefore normal to expect minimum Curie point depth (CPD) at the regions which have geothermal potential, young volcanisms and a thin crust. The maximum value of geothermal gradient (66.69 °C/km) and Heat flow (166.74 mW/m^2) occur at the Eastern edge of Lokoja where the Curie point depth also had the least value of (8.69 kilometres). Values of heat flow recorded in the study area exceeds the continental average value of 60 mW/m^2 which is indicative of anomalous values that are good sources of geothermal energy. The anomalous heat flow values in the range of 100 to 166 mW/m^2 trending E-W of Lokoja meet the recommended requirement for sighting a geothermal power plant for electrification and other industrial heating requirements. However, the least Curie point depth of 8.69 Kilometres at this prospective point will not be cost-effective when explored for geothermal energy.

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Delineation of Structures for Solid Minerals within Kubil (Sheet 128) and Wawa (Sheet 159) North Central, Nigeria from Aeromagnetic Data

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Abstract

To resolve the problem of artisanal miners using trials and error method to locate solid minerals, a modern geophysical techniques was employed to delineate structures that host mineral in the study area. The study focused on both (Qualitatively and Quantitatively) analysis of high resolution Aeromagnetic data to delineate the geological structures that serve as host to mineral within Wawa (Sheet 128) and Kubil (Sheet 159) Niger State, Nigeria. The area is bounded by latitude 4º00' and4º30E' to longitude 9º30' and 10º30'N. The aeromagnetic data was subjected to various filtering method such as production of Total Magnetic Intensity Map, Analytical signal, First vertical derivatives and center for exploration targeting (CET). The total magnetic intensity map comprises of both positive and negative anomalies with magnetic values within the study area ranges from -66.589 nT to 129.237 nT. Result of analytical signal depicts high amplitude response of magnetic anomalies ranges from 0.232 to 0.355 cycles in regions of shallow magnetic intrusive rocks and low amplitude response of magnetic anomalies ranges from 0.010 to 0.218 cycles in regions of thick sedimentation. The first vertical derivative helped to place both low and high magnetic susceptibilities and sets of lineaments which are the area of interest that serve as host for minerals.This was located around latitude 9º50' to 10º10'N within Yangari, Lasun Sarabe, Wawa Malete down to Doro across rivers Yakumosin. The lineament trends in North East and South Western direction. The major lineament which were mapped on the first vertical derivative were also mapped automatically on the centre for exploration target map at the same said region which is also region of mineralization in the study area.

Keywords: *Artisanal Miner, Solid Minerals, Structures, Lineament, Magnetic Anomalies, Magnetic Susceptibility*

INTRODUCTION

Geophysics is a very potent and vital tool of exploration and consistently used in detail surveys. There are a lot of geophysical survey methods which include gravity, magnetic, radiometric, seismic, and electrical resistivity. Each of the above survey method has a unique operative physical property like density, magnetic susceptibility, radioactivity, propagation or velocity of seismic waves, and electrical conductivity of the Earth (Kearey *et al*., 2002). These methods have been used to investigate the subsurface geology of an area of interest. Some of these methods can still be applied by flying the geophysical equipment namely magnetic, electromagnetic, radiometric and gravity. Airborne geophysics is an effective way for surveying a very large area quickly for regional exploration.

Aeromagnetic survey is the frequent type of airborne geophysical survey and has been recognised as a principal mapping tool for materials that are strongly magnetised (Murthy, 2007). Magnetic method seeks to probe the geology of the particular area due to the differences in the susceptibility of the field. These differences are as a result of the magnetic features of the rocks subsurface (Kearey *et al.,* 2002).The area under investigation is Kubil (sheet 128) and Wawa (sheet 159) in Borgu local government area of Niger State, North Central Nigeria, it is bounded by Longitude

4°0’0”E – 4°30 ’0”E and Latitude 9°30’0”N – 10°30’0’’N. The study area is located at the western part of Niger State which falls within basement complex and cretaceous sediment area is about 9 km away from New Bussa. The region has an undulating topography and the elevation varies between 279 m above sea level. This area of study is accessible through a network of major and minor roads in addition to several foot paths. The climate of the study area is that of a typical guinea savannah. There are two seasons associated with the climate; these include the rainy and dry seasons. The average total annual rainfall in this area is about 1300 mm and spreads over the months of April and October with the highest amount of rainfall being recorded between the months of August and September. (NIMET Seasonal Rainfall Prediction, 2020)**.**

The study area Kubil and Wawa under Borgu local Government Area of Niger State is located between Longitude 4º00'E – 4°30'E and Latitude 9°30'N – 10°30'N, it occupy the portion of the basement complex in Niger state. The Kubil and Wawa area comprises of meta sedimentary and meta-igneous rocks which have undergone polyphase deformation and metamorphism. These rocks have been intruded by granitic rocks of Pan-African age. Ten lithostratigraphic units have been recognized in Kubil and Wawa area (Figure.1).

MATERIALS AND METHOD

Materials

The total magne tic data and radiometric of Kubil (sheet 128) and Wawa (sheet 159) of southern part of the state were acquired. The geomagnetic gradient were subtracted from the map using IGRF. The research work use of Oasis Montaj software in the production of the total magnetic intensity (TIM) map and ternary map which was further subjected to different method.

The materials used for this research includes:

i. Aeromagnetic data covering the study area
ii. Geology map
iii. Geosoft (Oasis Montaj software)
iv. Microsoft Office

Method

Method for this research work included:

i. production of composite aeromagnetic map of the study area and application of reduction to equator and pole to remove dependence of the data on angle of inclination and declination
ii. Computing first vertical derivative to delineate near surface structures
iii. Computing the analytical signal so as to delineate region of out cropped near surface intrusive bodies and equally to place the anomaly directly above the causative body,
iv. Computing centre for exploration targeting to delineate major structures.

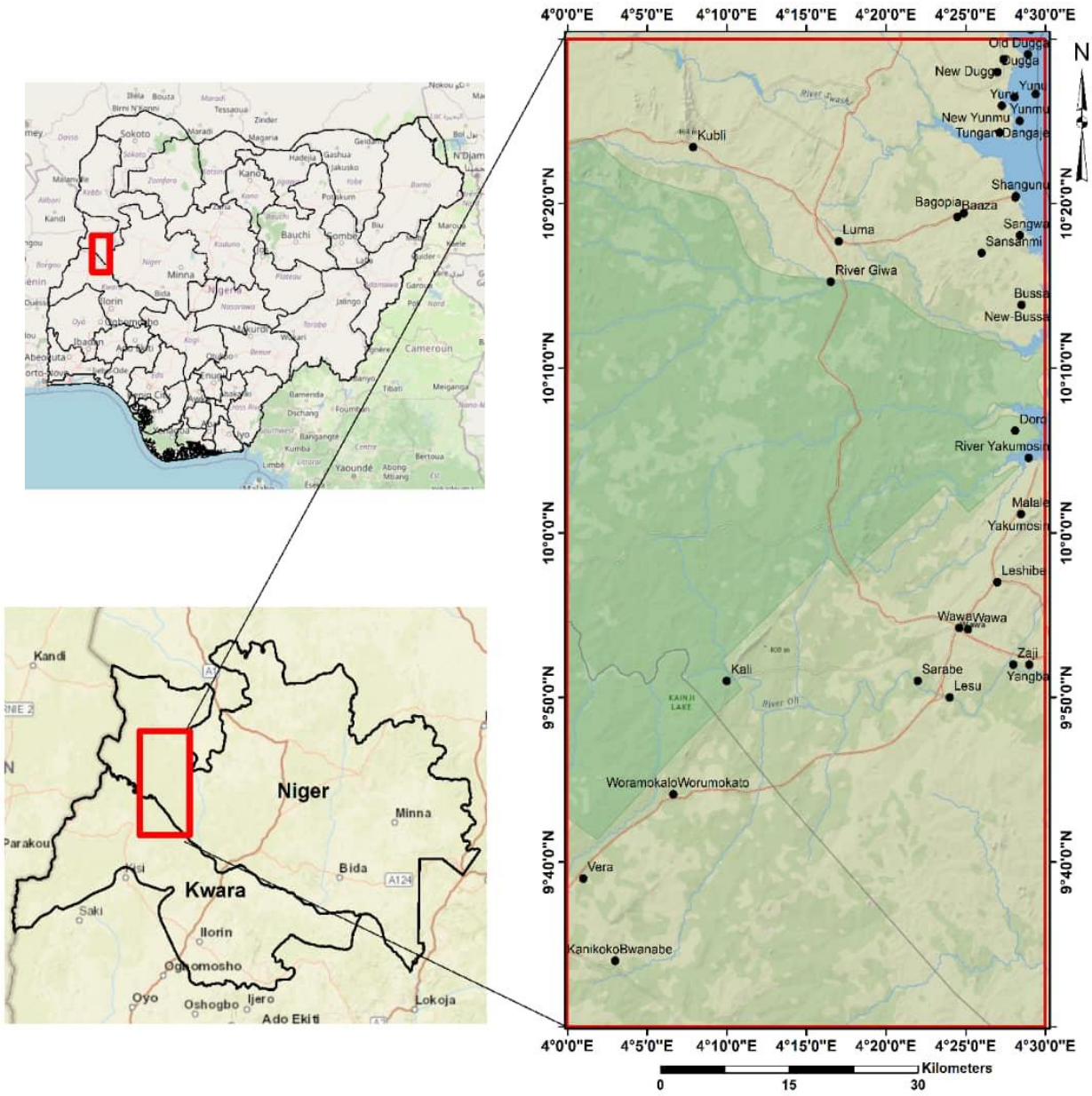

Figure 1: Location Map of the study area (Climate changing, 2019. Ministry Environmental Science Niger State)

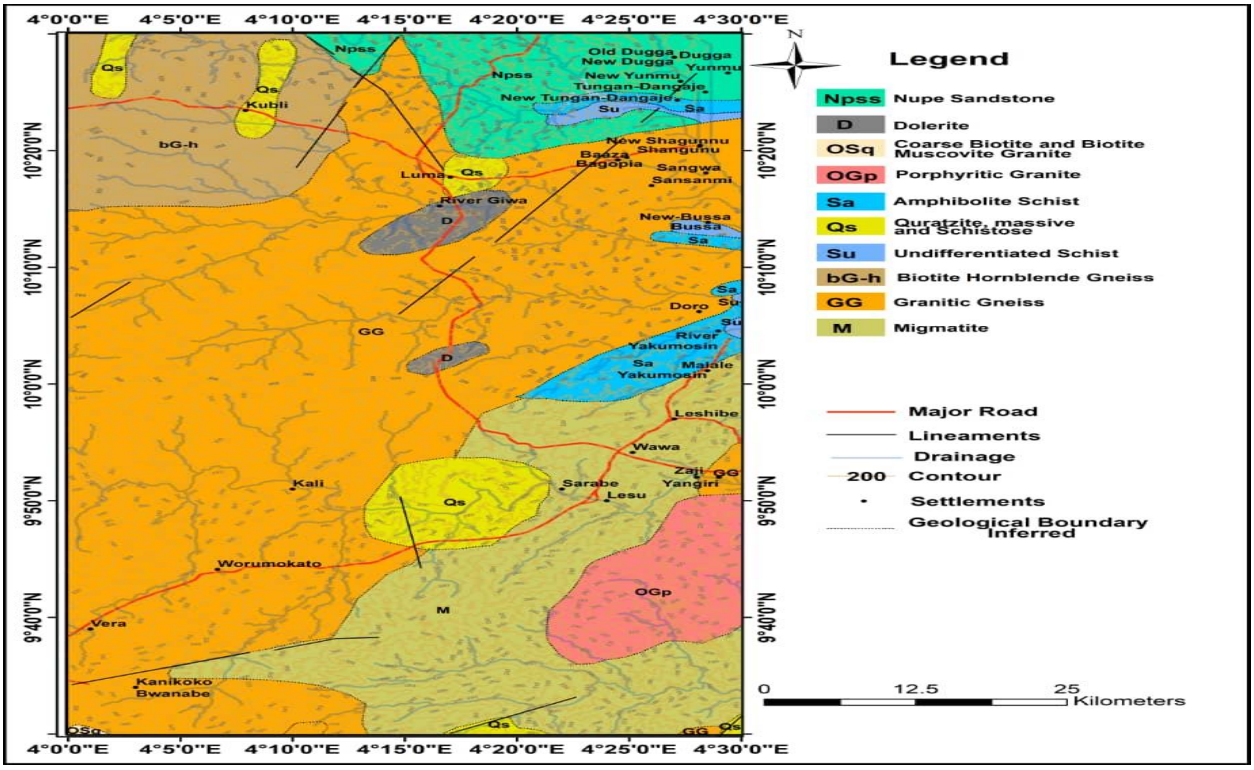

Figure 2.1: Geology Map of the study area (Modified by NGSA, 2009)

v. Correlating the structures from first vertical derivative (1VD) and Central Exploration Targeting (CET) to mapped region of mineralization

RESULTS AND DISCUSSION

- **Total Magnetic Intensity Map**

The total magnetic intensity map (Figure 3) comprises of both positive and negative anomalies. Magnetic values within the study area ranges from -66.589nT to 129.237nT. The mid-portion of the study area shows a relatively low susceptibility this can be as a result of thick sediment present in between Wawa and Kubil. The low magnetic susceptibility was also observed in between high magnetic susceptibility at the southern end of the study area.

- **Analytical Signal Map**

Result of Analytical Signal (figure 4) depicts the amplitude responses of the magnetic sources in the study area. High amplitude ranges from 0.232 to 0.355 cycles represents region of magnetic rocks where the major anomalies were clearly observed and delineated above the causative bodies. While low amplitude response of magnetic sources ranging from 0.010 to 0.218 cycles represent regions of high sedimentation.

- **First Vertical Derivative Map (1VD)**

On the first vertical derivative map (IVD) (figure 5a), Regions of lineaments are marked with deep blue and deep red colour depending on the susceptibility of the anomaly. These lineaments are also mapped on the grey scale of first vertical derivative (FVD) map (Figure 5b). Areas of interest where mineralized lineament are mapped are denoted as a swamp of linear diagonally structures starting from the North East and trending in South Western direction, around latitude 9º50'N to 10º10'N, situated within Yangari Village to Lasun Sarabe, Wawa Malete down to Doro across rivers Yakumosin.

- **Centre for exploration Targeting (CET) Map**

Centre for exploration targeting is a method of delineating and mapping lineaments automatically. The results from CET map (Figure 6) interestingly correlate with the lineaments mapped on the first vertical derivative.

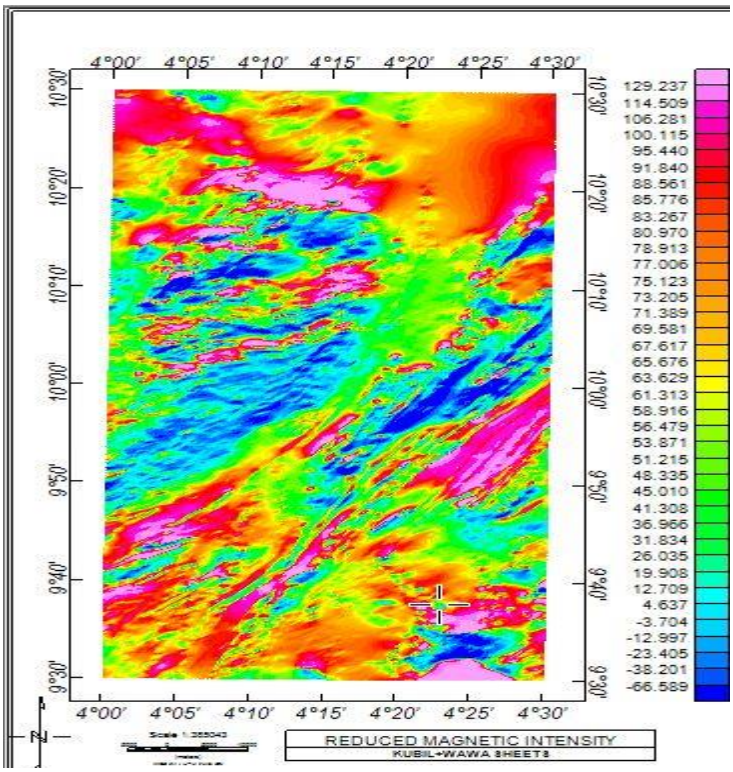

Fig. 3: Total Magnetic Intensity Map (TMI)

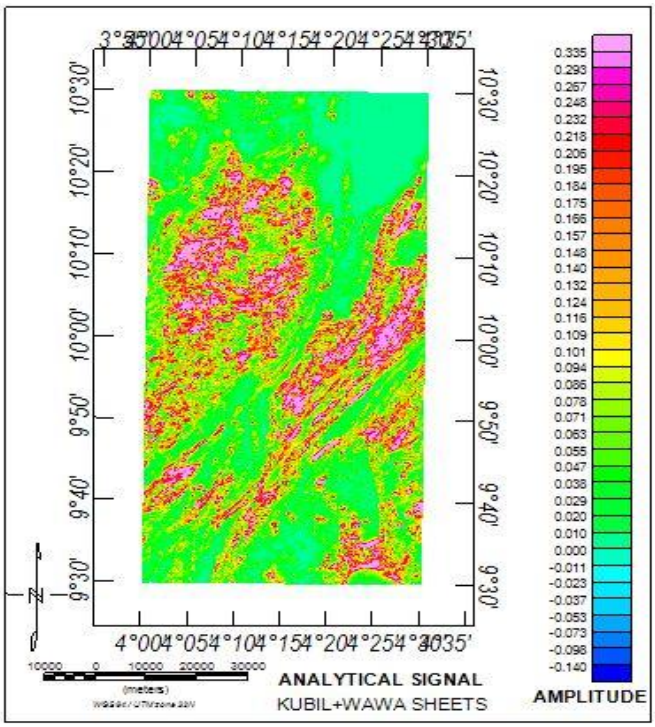

Fig. 4 Analytical Signal Map

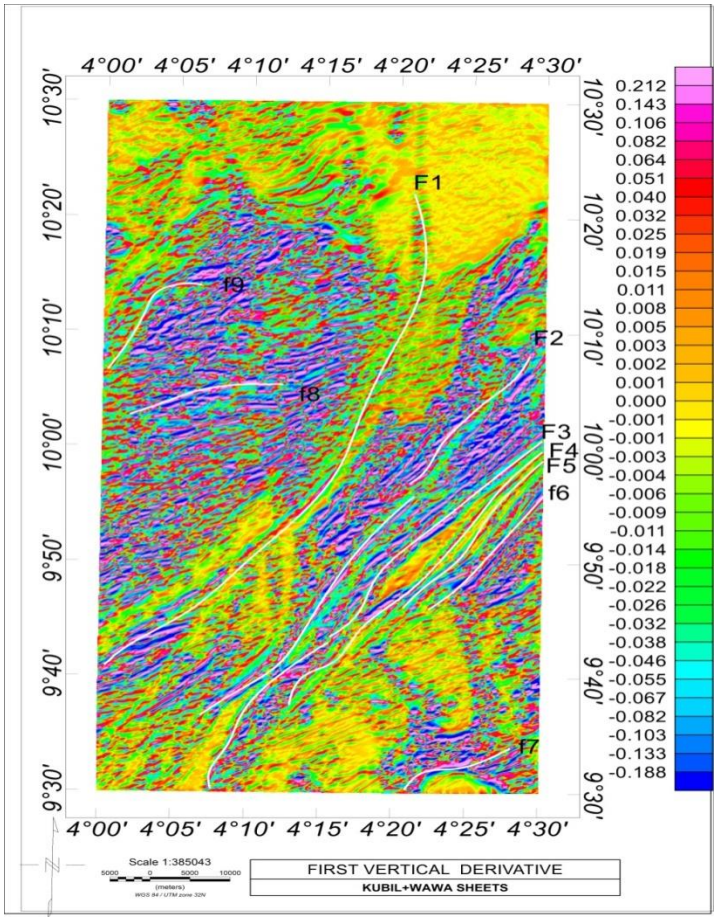

Figure 5a: First vertical Derivative Map of the study area

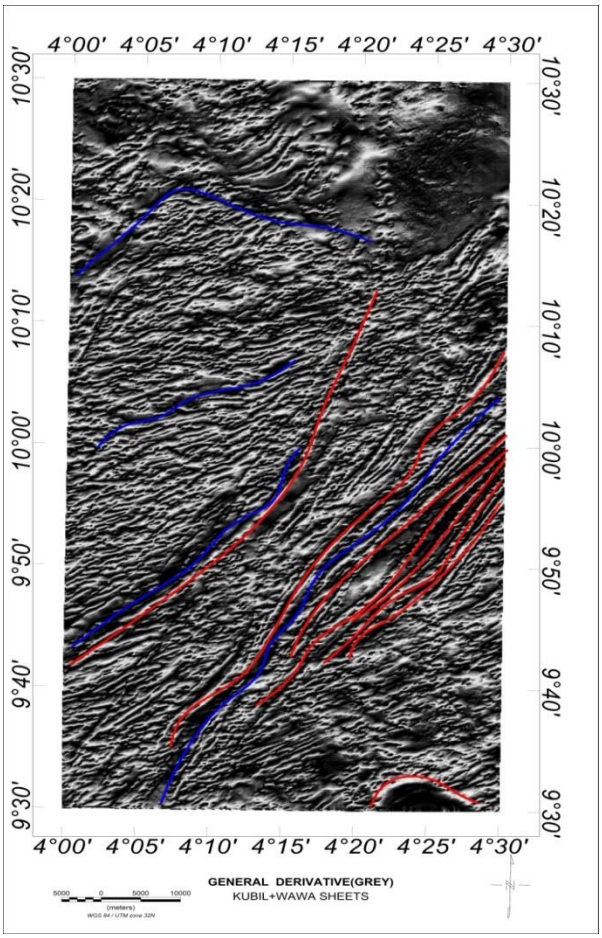

Figure 5b: First Vertical Derivative (Grey Scale) of the study area

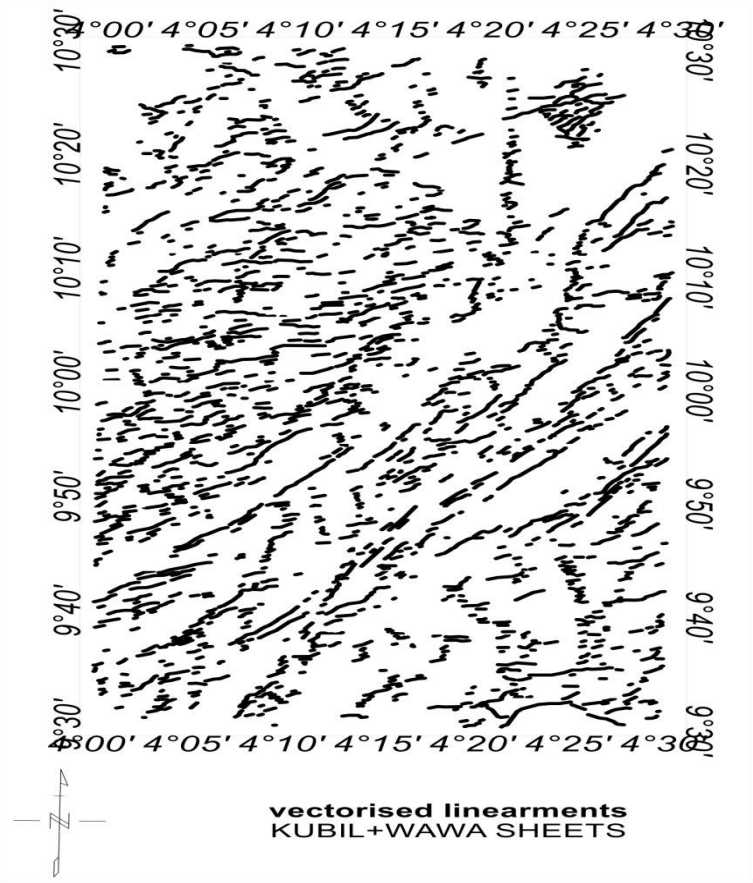

Figure 6: Structure Map of the study area

CONCLUSION

The first vertical d erivative map helped to delineate the region of interest where mineralised lineaments were mapped and denoted. The CET Mapped lineament that correlate with those mapped on the first vertical derivative. The regions of major lineaments which corresponds to Yangari, Lasun- Sarabe, Wawa - Malete down to Doro across rivers Yakumosin, located between latitude 9°50'N to 10°00'N was mapped as region of mineralization in the study area.

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Effects of Density of Ground Control Points on the Accuracy of Maps Produced Using UAV: A Review

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Abstract

A large number of unmanned aerial vehicle (UAV) operators with little or no surveying and photogrammetric knowledge is constantly increasing because of the wide availability UAV and their ease of use. Also there are no easily accessible guidelines regarding the choice of some of the parameters (flight height, specification of the lens and camera, and weather condition) that may affect the quality of the orthophoto obtained from a UAV. This affect to a large extend the accuracy of UAVs maps. Another important factor that determines the precision of UAV maps is Ground control points (GCPs). In order to produce a centimeter accuracy maps, the use of GCPs is essential. In this study, we investigate the effects of the density of GCPs on UAV based maps and concluded that to obtain high accuracy of geometric correction of UAV maps, the location and distribution of GCPs should be taken into consideration.

Keywords: Photogrammetric, surveying, Unmanned aerial vehicle, Orthophoto, Ground control points, Flight parameter.

1. INTRODUCTION

Photogrammetry is a three-dimensional coordinate measuring technique which utilizes photographs as the fundamental medium for measurements. Aerial photogrammetry involves the acquisition of aerial photographs using metric a camera from an aircraft, helicopter, hot air balloon, kite or parachute. Both planimetric and topographic maps can be prepared at a specified standard of accuracy from aerial photographs. However, aerial photogrammetry is expensive especially for large scale mapping (Brynson and Sukkarieh, 2009). It is expensive and time consuming due to the need for appropriate planning in order to gain efficient information. Unmanned aerial vehicle (UAV) remote sensing offers an alternative with added advantages over manned aerial vehicles. Some of the advantages are: flexibility, low cost, safety, reliability, low flight heights, high precision and large scale measurements that save manpower and material costs (Cao *et al.*, 2016). Mapping with UAV provide a simpler solution for low budget projects with time constraints and requires less human interface (Jaakkola *et al.*, 2010), this resulted in high demand of aerial photogrammetric products due to the developments in term of design, research and production of UAV platforms (Cesetti *et al.*, 2011). But the accuracy of the three-dimensional maps generated using UAV images is affected by large number of factors such as camera focal length and flight altitude (Clapuyt *et al.*, 2016), camera orientation and image quality as investigated by Leitao *et al.*, (2016).

Furthermore, the geometry of the ground control points (GCPs) used to gereoference the acquired images has been cited as one of the most important factors that can affect the accuracy of the UAV based maps (Berthling *et al.*, 2014). Ground control points (GCPs) are used in the process of indirectly georeferencing unmanned aerial systems (UAS) images. A minimum of three GCPs are required but increasing the number of GCPs will lead to higher accuracy of the final results (Tahar *et al.*, 2014). It is worth mentioning however, that exceeding the number of ground control points is a time consuming process both in the field and during computation. The number of GCPs used in the process of georeferencing affects the positional accuracy of the final products. An appropriate distribution of GCPs is also needed to deal with absolute

orientation of the image block in the coveted coordinate outlined, as well as mitigate block deformation effects which are basically from remaining systematic errors in the camera calibration and alignment (Sharan *et al.,* 2018)

This review paper will then address:

- The answer to the question of how many ground control points are necessary in order to derive high precision results.
- The effect of the density and accuracy of GCPs on the processing time and
- The effect of the density of the GCPs on the accuracy of the UAV-based map

2. CURRENT TECHNICAL ISSUES IN MAPPING WITH UAV

This paper takes a look at some of the major issues in mapping with UAV, these issues are discuss briefly as follows.

2.1Choice of Flight Parameters

For specific mapping surveys, a spatial resolution of less than 10cm is generally good. This translates to a requirement of maximum 10 cm/pixel, i.e. the Ground Sample Distance (GSD) should be 10cm/pixel or less. For a certain GSD, the flight height depends on the focal length (FL), the sensor width (S_W) and the number of pixels (PN) per photo width (He *et al.,* 2012). From the equation 1 below, it is evident that keeping the flight height, number of pixels per image width and sensor width constant and increasing the focal length, gives a better spatial resolution. Resolution of the maps depends on the flight height and the size of the sensor or lens giving a favorable weather condition. Flight height is restricted by the type of the UAV (rotary or fixed wing), the aviation regulations and the application itself. For a flight height of more than 80 m, a sensor size of 7360 pixels and a 15 mm lens can achieve a GSD better than 8mm/pixel, a value that is adequate for most mapping (Francesco and Fabio, 2012).

$$FH = GSD * FL * PN/SW \quad (1)$$

Where:

F_H is the flight height (m), *GSD* is the ground sample distance (m), F_L is the focal length (mm), P_N is the number of pixels per image width, S_W is the sensor width (mm).

The focal length of the camera also plays a significant role in the flight height as it can result in the same or even better resolution at a flight height twice the one achievable by a lens with a smaller focal length. Choosing a higher flight height reduces the flight time and the post-processing time since the number of acquired images covering the same area is significantly smaller.Another factor to be considered is the number of images acquired as it significantly affects the post-processing time. The later depends on the processing software used and the camera. For the same processor and number of images, the camera also affects the processing time. For example, a 56MP camera will result in a significantly different, that is, three times higher number of pixels per image compared to a 16MP camera.

2.2 Ground control points

The number of ground control points (GCPs) can significantly affect the accuracy of the orthophoto (Tonkin and Mingley, 2016). The number of GCPs required depends on the topography and the method used to establish a GNSS position. For example, post processing kinematic (PPK) and Real-time kinematic (RTK) only require one GCP. This is the minimum GCP number recommended to allow for the control of the height component of the GNSS

measurements. The minimum number in all other cases is at least four or five per flight and their geometrical distribution should be suitable for the site topography (Tonkin and Mingley, 2016). GCPs are also used for the calibration of the camera. The calibration of a camera for photogrammetric purposes has been extensively discussed in the work of Wang *et al.* (2008) and Balletti *et al*. (2014).

2.3 User errors

As with every other technology, UAVs require sensible use. In many cases, the result of a UAV survey reflects user errors. One of the parameters that are controlled by the user and affect the quality of the orthophoto is the forward and side overlap. The recommended value for the forward and side overlap is at least 80% for mapping surveys that require high accuracy (Gatewing, 2013). This might not be always achievable if the shutter speed of the camera is too slow for the chosen flight height and UAV speed. Also it can be compromised by not anticipating the effects of topography and the UAV orientation overlap. The effect of the UAV orientation can compromises the overlap value, the pitch, roll and yaw values. If the image isn't taken in the right orientation, for example due to excessive yaw because of unfavorable wind direction, no amount of reorientation will make the photos overlap.

Another factor affecting the quality UAV images is wind direction, although wind direction is not the only meteorological factor affecting the quality of a UAV survey; a UAV flight should take place in good light conditions (Francesco and Fabio, 2012).

2.4 Type of UAVs platform

A UAV is a tool and as such it should be used for the right application. For mapping/monitoring of small areas, i.e. less than 10,000 m^2, a vertical take-off and landing (VTOL) is more appropriate, while a fixed wing is more suitable for covering larger areas (Gatewing, 2013). For the fixed wing aircraft (UX5 HP) the flight lines will not strictly be straight above the area under survey as would have been supposing VTOL was used. Instead, the lines will be curved along the area of interest due to the turning circle required by the UX5 HP, resulting in images that have compromised overlap.

3. THE NEED FOR GROUND CONTROL POINTS IN MAPPING WITH UAV

Ground control points (GCP) are point on the ground whose coordinates are known in the spatial coordinate system (longitude, latitude and altitude coordinate). Traditional surveying methods in the field such as tachymetry, GNSS-measurement or other available sources can be used to obtain their coordinates. To calculate the coordinate of each point on the aerial photograph, many ground control points coordinates are required and the photogrammetry process followed. GCP in nature determine the position of the aerial photo in the coordinate system. GCPs are essential for orientation and placement of aerial photographs in the spatial coordinate system, which is a requirement for the production of georeferenced metric and 3D models of the earth's surface (Sharan *et al.,* 2018). Computer processing and analysis require spatial coordination models, from point cloud to orthomosaics. Generally, even for large areas of the land it is sufficient to use from 5 to 10 ground control points. Exceeding this number of ground control points can contribute to a higher accuracy. The more the terrain is naturally varied, the higher the number of ground control points are necessary to achieved the desired accuracy.

4. RELATED RESEARCH WORKS ON THE PRODUCTION OF UAV-BASED MAPS

Many researchers have investigated different aspect of image processing for various applications and they were able to identify numerous parameters that affected the quality of UAV images. For example, Shahbazi *et al.*, (2015) did several tests varying the number and location of GCPs, they found that orthophoto georeferenced with a larger number of GCPs is more accurate than those georeference with few GCPs. The study of Tahar *et al.*, (2014) as well as Rosnel and Honkavaara (2011) also concluded that orthophoto accuracy increases with increases in the number of GCPs. A similar conclusion was reached by Tonki and Midgley (2016), who showed that beyond a certain number of GCPs the accuracy of the orthophoto does not increase further. All the accuracy assessment studies were performed on flat and undulated terrains and on well-structured surface which facilitate orthophoto construction. Saskia *et al.*, (2017) performed a rigorous assessment of the impact of number and disposition of GCPs on orthophoto generation on glacier surface.

Glacier surface texture mainly constituted of ice and snow that can have high reflectance, lack of structure and low contrasts which make photogrammetry challenging. The percentage of image overlap can also impact on the UAV maps accuracy, this was shown on the study of Rosnell and Honkavaara (2012), they performed several UAV flight over the same area, varying the longitudinal ground overlap from 60% to 90%. They found that increasing the overlap clearly increase the map accuracy due to a better estimation of the image block orientation parameters.

Another investigation was performed by Valeria *et al.,* (2018) to determine the number of GCPs in order to georeference a UAV images taken at two heights, in different scenarios. In another assessment of ground control points in UAV image processing for slope mapping studies, Tahar *et al*., (2012) produced photogrammetry output such as stereo model, contour lines, digital elevation model (DEM) and orthophoto from a simulation model with a dimension of 3m by 1m in the simulation model, ground control points (GCP) and check points (CP) were established using a total station. An increasing number of studies have already assessed variation in the number of ground control points (GCPs) used (Harwin *et al.*, 2015). The research reported here adds to our understanding of reproducibility based upon GCP number and distribution, their work differs to that of Clapuyt *et al*. (2016), because it covers a site of moderate relief, rather than the 'gentle topography' assessed by Clapuyt et al., (2016) and uses a fixed focal length lens for image acquisition. Smith *et al*., (2016) study address aspects of GCP distribution, which is of interest due to the time intensive nature of GCP collection.

James and Robson (2012) highlight that GCPs should be located toward the edge or outside the area of interest, and whilst highlighting that 3 GCPs can be used, the collection of more GCPs is preferential for facilitating accurate reconstruction. Here, the use of both 3 GCPs and 4 GCPs (or greater) may result in acceptable levels of error depending on the survey purpose, however, as previously highlighted excess GCPs did not appear to substantially improve survey quality. Thus, the collection of excess/redundant GCPs is highly desirable if error, which will vary spatially on resulting derivative datasets, is to be better understood. The findings of this assessment accord with existing literature which highlight that a uniform coverage of GCPs is preferential across the area of interest, and that error should be anticipated in areas not subject to ground control (Eltner *et al.,* 2016).

5. RESEARCH ISSUES THAT EMERGE FROM THE RELATED WORKS ON THE PRODUCTION OF UAV BASED MAPS

Recent researches have begun to challenge the above paradigm and argue for more varied approaches to understanding the geometrical effects of GCPs on orthophoto accuracy, for example:

Table1: Some Recent Articles on the Effects of Ground Control Points on UAV-Based Map Accuracy

S/no.	Year	Tittle of article	Journal	Summary of findings
01	2015	Development and evaluation of a UAV photogrammetry system for precise 3D environmental modeling	Sensors	A minimum number of GCPs could provide a high accuracy level if they were distributed evenly over the whole zone and their visibilities in images were maximized.
02	2015	UAV-based point cloud generation for open-pit mine modeling	The international archives of the photogrammetry, remote sensing and spatial information science	They found that orthophoto georeferenced with a larger number of GCPs is more accurate than those georeference with few GCPs.
03	2016	Ice-cored moraine degradation mapped and quantified using an unmanned aerial vehicle	Geomorphology	The research showed that map accuracy increases with increases number of GCPs, and that when a certain number of GCPs is attained, the map accuracy does not increase further.
04	2016	Assessing the accuracy of ortho-image using photogrammetric unmanned aerial system	International archives of photogrammetry, remote sensing spatial information science	Distribution and wide range of GCPs is important to georeference bundle block adjustment, considering that reliability of camera calibration is based on accuracy of GCP.
05	2017	Assessing the geometric accuracy of UAV-based orthophotos	South African journal of Geomatics	Unmanned aircraft system images can be employed for updating and revision of topographic maps with minimum number of GCPs and a high percentage of forward and side overlaps

06	2017	Accuracy Assessment of Digital Surface Models from Unmanned Aerial Vehicles' Imagery on Glaciers.	Remote sensing	This research study the influence of the distribution of GCPs for georeferencing the UAS images, it demonstrate that increasing the number of ground control points will increase the accuracy of the final products.
07	2018	Determining the optimum number of Ground Control Points for obtaining high precision results based on UAS images	Proceedings	It was conclude that in order to obtain high accuracy of the final products, a density of 1 GCPs per 200 m^2 is necessary.
08	2018	Accuracy assessment on low altitude UAV-borne photogrammetry outputs influenced by GCP at different altitude	Conference series: Earth and Environmental Science	Implementation of GCPs to the image processing improved the accuracy from 0.2 to 1 meters or better, areas with differential terrain profile needs more number of GCPs to measure the elevation of each point accurately to produce accurate model.

- In most of the previous researches ground control points (GCPs) were established by total station and Real-time Kinematic Global Positioning System for georeferencing the data, no special attention was given to Continuously Operating Reference Station (CORS) method of georeferencing. Compared with the real-time kinematic global positioning satellite (RTK-GPS) method, the CORS-GPS method is more stable and reliable, which improves the accuracy of the GCPs (Yu Liu *et al.,* 2018).
- Also most research focuses on the configuration of the GCPs, without looking at the angular effects. The angle between GCPs can also have an effect during image processing because the angle between GCPs will be calculated during bundle adjustment process (Tahar *et al.,* 2012).
- Analysis between surface roughness and orthophoto is also yet to be investigated.
- UAV image acquisition and structure from motion image procession need to be integrated. This is important if source of errors are to be minimized when acquiring dataset.
- Difference in accuracy with respects to GSD's should be tested out to obtain the optimal GSD for mapping and number of GCPs for study area consists of differential elevation profile.

6. CONCLUSION

Based on this review, the imagery of low altitude UAV can be used for large scale mapping with the co-act of GCPs. Without GCPs, the accuracy of the photogrammetry output is

normally poor, but once ground control has been established and implemented to the image processing, the accuracy improves to the nearest meter or better accuracy.

GCPs must be well distributed in the area of study, although more number of points does not necessary replicate higher accuracy of the results. Eight to ten GCPs is enough to produce a reliable orthophoto/map. Areas with undulated terrain profile require more number of GCPs to measure the height of each point accurately to produce accurate model. Data processed with GCPs will produce better results which are reliable with the least errors compared to data processed without GCPs.

The following points conclude the whole review:

- The bad location and distribution of the GCPs lead to increase in the average RMS error value of correction of an image.
- The effect of bad location of GCPs is more severe than that of bad distribution of GCPs on the correction accuracy.
- To obtain high accuracy of geometric correction of UAV images, the location and distribution of GCPs should be taken into consideration.

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Factors Influencing Land Use Changes and Conversion: A Critical Review

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Abstract:
Land use alteration occurs when a particular land is changed from the use that was initially allocated due to invasion and succession, economic rents, highest and best use and other factors that incorporates urbanization in its entirety. Many studies have focused on identifying the driving forces shaping urban development patterns, such as urban scale, and rate and location of land use conversions. The study sought to identify the factors influencing land use changes and determine whether the Bid Rent Theory by Alonso is actually at play in explaining the factors responsible for land use changes in different climes. The driving forces of land use change are numerous, multifaceted and interwoven. The study adopted the use of secondary data from journals, research articles, books obtained through printed and online resources. Going by the vast literature on land use change factors, population growth, socio-economic, socio-cultural, technological, and natural factors as well as national policies and globalisation are the recognised motivating factors of land use changes. However, there are other drivers of land use change that are peculiar to developing countries like Nigeria. These include inter-urban migration as well as security and safety considerations. The Bid Rent Theory advocated the Willingness To Pay concept which explains the increase in demand for land and its changes. The identification of these drivers of land use change and conversion and their intricacies will help in terms of policy formulation to improve land use planning activities, sustainably manage land resources, reduce housing deficit and generally improve the lives of the citizens by boosting the national economy.

Keywords: *Land Use, Land Use Change, Land Use Change Factors, Bid Rent, Willingness to Pay.*

INTRODUCTION

The complete alteration of particular land use type to other land use types connotes land use change (Tilumanywa, 2013). Land use change has been defined by Ogungbemi (2012) as any use or development that is dissimilar to the use last endorsed by the town planning authority. A particular land use can be changed into another one just as land can be changed from a forest to a farmland and then later converted for residential purposes; hence, experiencing a series of land uses (Ogungbemi 2012).

The outcome of complex interplay between man and his physical surroundings is land use change patterns. Specifically, land use alteration occurs when a particular land is changed from the use that was initially allocated due to invasion and succession, economic rents, highest and best use and other factors that incorporates urbanization in its entirety (Ademola, 2012).

Many studies have focused on identifying the driving forces shaping urban development patterns, such as urban scale, and rate and location of land use conversions (Song, 2015). Researchers have used standard Monocentric city models (both closed city and open city models), and extended Monocentric city models to investigate the determinants of urban spatial scale of urbanized areas across the world (Ke et al., 2009).

Theoretical models define that four basic factors – population, income, commuting cost, and price of rural land – explain variations in urban spatial scales. Empirical analyses of cities across the world confirm the theoretical derivations with the following results (Ke et al., 2009). For the US cities, the population and income variables have positive and significant effects on the spatial size of urbanized areas; the expenditure on transportation, a proxy for commuting costs, has positive effect on urban spatial scale and thus confirms the predicted negative relationship between urban size and commuting costs; and the higher agricultural land rents surrounding urban areas can result in smaller cities in the United States (Song, 2015).

Liu (2010) provided a summary of influencing factors of land use. The factors include demography (population size, growth and density); location (distance to settlements, markets, employment, proximity to the urban structure); economic (returns on land use, commercialization of housing, job growth, cost of land use conversion); social (prestige and opulence, human behaviour and values); land use planning (zoning and tenure); land geographical and geological features; neighbourhood (availability of utilisable sites, developed areas agglomeration); and level of technology available.

This study undertook a review of previous empirical research work done in the aspect of influencing factors of Land Use Changes and Conversion. The study also sought to find out whether the Bid Rent Theory by Alonso (1960; 1964) is actually at play in explaining the factors responsible for land use changes in different climes. The study's methodology follows this section while section three presents the review of empirical literature. The findings are discussed in section four, and section five concludes the study.

METHODOLOGY

A review of previous research works was conducted where a total of 18 empirical research studies were presented in a table and analysed descriptively. The bulk of the data used for this study was obtained from secondary sources. The secondary data sources include journals, articles, books, of both printed and online resources.

THE REVIEW OF EMPIRICAL LITERATURE

The Urban Land Market Theory (Bid rent function) by Alonso (1960; 1964) modelled after von Thünen's theory was widely renowned and is considered as setting the foundation upon which a series of modern econometric tools have been advanced to analyse diverse land use and land value issues. In order to isolate factors attributable to the household's willingness to pay (WTP) for access to the Central Business District (CBD) of an urban centre, Alonso (1960; 1964) employed the concept of bid rent. Bid rents have been defined as the maximum rent that could be paid for an acre of land at a given distance from the market centre, if the activity in contention is to achieve normal profit (Angel & Blei, 2016).

Alonso (1960; 1964) posited that households make preferences among substitute locations based on the utility or satisfaction that they expect to realize from such choice. The concept of willingness to pay (WTP) to achieve or maintain utility is very relevant to land use and property value studies, since in actuality, what really determines land use is the interest in such land. The said interest consequently creates demand which sustains property values and brings about changes in land uses (Gwamna, Wan Zahari & Ismail, 2015).

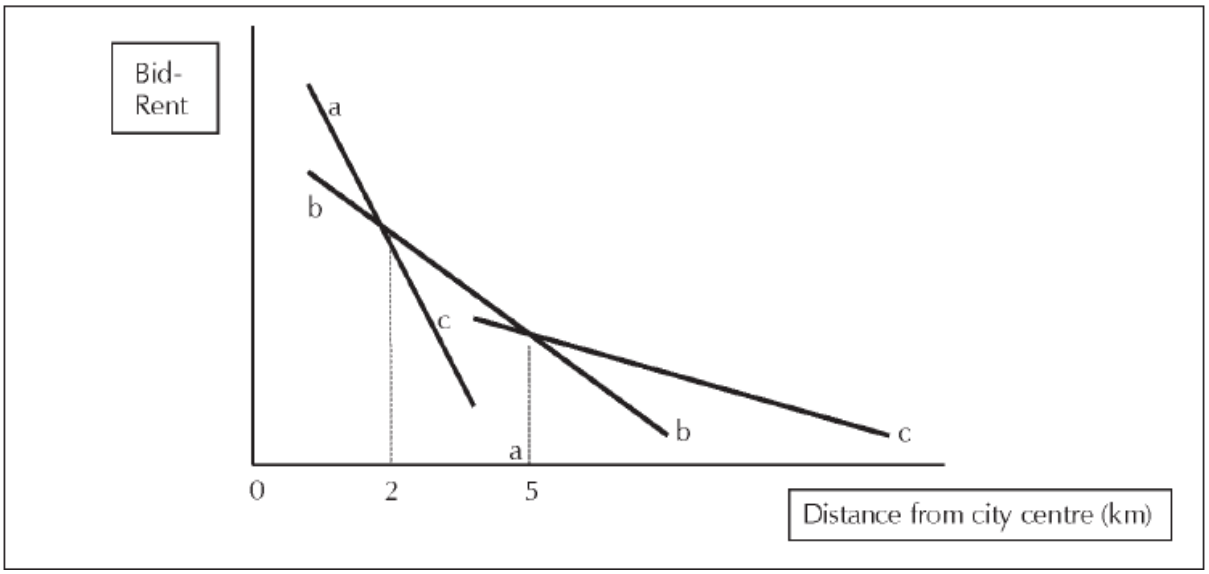

Figure 1: Alonso's bid rent distance relationship (Balchin, Bull & Kieve, 1995)

Land rent manifests itself through the bid rent, or, the maximum amount that any land user would be willing to pay for using that land (Alonso, 1964; Meyfroidt et al., 2018). Land use extent and intensity change along with bid rent changes, affected by a myriad of factors such as road construction, new technologies, climate change, or property market situations. Such changes move the land use frontier, usually involving the expansion of the more profitable land use (Walker, 2004; Angelsen, 2010).

The driving forces of land use change are numerous, multifaceted and interwoven (Rowcroft, 2005). Furthermore, they diverge and function within a series of dimension from local resource administration and utilisation to national scheme to global directions such as international markets and global climate change (Antrop, 2006; Olson et al., 2008; Hasselmann et al., 2010). Going by the vast literature on land use change factors, population growth, socio-economic, socio-cultural, technological, and natural factors as well as national policies and globalisation are the usually recognised motivating factors of land use changes (Ramankutty et al., 2002; Lambin et al., 2003; Bürgi et al., 2004; Lambin and Geist, 2008; Ningal et al., 2008; Hasselmann et al., 2010).

However, there are other drivers of land use change that are peculiar to places in Nigeria. These include inter-urban migration as well as security and safety considerations (Ajibuah, 2010; Gandu, 2011; Aliyu et al., 2013).

Empirical works focusing on the driving forces and dynamics of land use change were reviewed in order to highlight the major areas of such works. The review dwelt on issues, research methods, findings as well as this study's authors' comments on them. This is presented in Table 1 below.

Table 1: Empirical studies on factors influencing land use changes and conversion

	Author/ country	Issues/Factors/ Themes	Methods	Findings	Remarks/ Comments
1.	Raharjo 2005 Indonesia	Factors influencing change of land use from residential to commercial use	Area mapping and descriptive statistics.	Factors influencing land use change were accessibility advantage, high level of profit returns by the proliferation of commercial activities, demographic characteristics, and ambiguous government policy on planning.	The study only analysed tangible factors influencing changes in land use. It did not give regard to the important aspect of property values.
2.	Han et al. 2009 China	Physical and socio-economic factors affecting urban land's spatial distribution.	Remote sensing and multivariable stepwise regression	There is increase in urban lands while farmlands are decreasing owing to conversion. Population, economic factors and transportation bringing about growth in urban land use.	The rise in demand for land and increase in transportation activities which influence land uses are all induced by increasing population.
3.	Clark 2010 U.S.A	The political and institutional determinants of land use change	Conceptual land use model is proposed from previous theories, models & empirical studies	Government affects the demand and supply side by amenities or disamenities, taxation, public transit, subsidies, government land utilization, land conversion costs, rezoning and the release of public land for private use.	The study articulates the role and power of the government in influencing land use patterns.
4.	Swangjang & Iamaram 2011 Thailand	Land use patterns near Suvarnabhumi International airport before and during the airport devt.	GIS themes and layers to map land use patterns, paired T-test to analyse the changes.	Urban expansion and land use change in the form of new property projects occur in areas close to the airport. Also, agricultural lands have been converted mostly for residential purposes.	The study outlines the role of government intervention and projects in influencing land use.
5.	Li et. al. 2013 China	Land use conversion and identification of drivers of land use change in China.	GIS database on land use to estimate an econometric land use model.	Results portrayed that generally, economic forces such as demand, increasing urban land value, rising wage rates and rising GDP were the major drivers of land use changes in China.	Economic forces exerting influence on the dynamics of land use.
6.	He et. al. 2013 China	Economic growth as driver of land use change	Correlation analysis and Structural equation analysis	Agricultural land has been converted for urban, transportation and industrial use. Found strong association between land use change and GDP expansion. Analysis indicated that economic growth drive land use change.	Economic forces exerting influence on the dynamics of land use.
7.	Alam 2014 Bangladesh	Land use pattern determinants and their corresponding changes over time	Cross-sectional data using questionnaire and focus group, logistic regression and cost-benefit analysis	Agricultural land has been converted for settlement purposes and the building of roads, communication and business infrastructure. Economic benefits, neighbourhood land use, family demand and land use cost (rent) affecting land use decisions on individual basis.	Residential land use and infrastructure provision crowding out agricultural land use.
8.	Kamh et al. 2012 Egypt	Urban land cover change in the Hurghada area.	GIS and remote sensing coupled with socio-economic data.	Coastal tourist activities, population growth/pressure and city location were the foremost factors behind the development and extension of the urban area.	Human and environmental factors at play in influencing land use change.
9.	Tilumanywa 2013 Tanzania	The major changes in land use and the factors accountable for such changes.	Employed both qualitative and quantitative approaches. Interviews, questionnaire,	Demographic, socio-economic, socio-cultural, natural and political factors responsible for the changes in land use. Government policies have also played a part in this regard.	The study revealed the complex and intricate interplay of the factors influencing land use change.

			observation and satellite imageries.		
11.	Adebayo 2009 Nigeria	Impact of urban land use changes on property rental values.	Simple descriptive statistics.	Major land use change determinants were demand and supply factors. Others were complementarity, accessibility, and infrastructural facilities. The land use conversions had prompted parallel changes in property values in the study area.	Only descriptive statistics were used for data analyses which were inadequate for a study of such magnitude.
12.	Sunday 2011 Nigeria	Assessment of land use changes in Abuja.	GIS to map the changes and then Chi-square and T-test to validate the findings	The major factors causing land use changes were land commercialization and capitalization, and increase in rural-urban drift.	Land speculation and rural-urban migration influencing land use in a developing country.
13.	Ndabula et al., 2013 Nigeria	The dynamics of land use and land cover change in Kaduna.	GIS and remote sensing applications were used to map the changes.	The main influencing force of the land use changes was the socio-economic factor of urbanization processes such as emergent population, economic, technological and institutional growth.	Urbanisation processes with its attendant urban sprawl and changes in land use.
14.	Oduwaye 2013 Nigeria	Implications of changing land use structure on land use development	Factor analysis and principal components Analysis (PCA)	Infrastructural and economic factors were the important factors influencing how land is used. Major determinants of residential development are accessibility, infrastructure (road) and land value.	Availability of infrastructure aided and complemented property development bringing about land use changes.
15.	Saleh et al. 2014 Nigeria	Agricultural land use change and the driving forces of land use change.	GIS and remote sensing to determine the degree of agric land-use change from 1980 to 2012.	Agricultural land had decreased significantly. Major driving forces of land use changes were increase in population, urban growth, socio-economic and political factors, environmental factors; inadequate land use planning and non-enforcement of planning laws/ development control.	Built-up areas had largely taken over farmlands due to demand occasioned by population increase and other factors.
16.	Wizor 2014 Nigeria	Dynamics of residential development in Port Harcourt.	GIS approach	Croplands had been converted to residential use. Residential land use one of the prominent land uses in the northern and eastern parts of the metropolis.	Demand for land for residential purposes causing land use conversions.
17.	Oruonye, 2014 Nigeria	Impact of road construction on land use pattern	ANOVA and simple descriptive statistics	Rise in values of property near newly constructed roads. Complementarity of the new roads attracts people to the area and creates new demand for property.	Road construction opening up an area and bringing about land use intensity around that area.
18.	Adzandeh et al., 2014 Nigeria	Factors causing urban growth and expansion.	Remote sensing and Markov chain model.	Built-up areas have encroached into vegetation areas. Factors responsible for this are population increase, rural-urban drift, proliferation of commercial and trading activities, and the emergence of educational institutions.	The distinct feature of a dynamic city is inevitable changes in land use. All human activities require land but land is physically limited in supply resulting in some uses dislodging others.

DISCUSSION

From the review of literature, a number of factors are responsible for land use change. Population increase is one of the main factors influencing changes in land use (Han et al., 2009; Kamh et al., 2012; Tilumanywa, 2013; Appiah et al., 2014; Sunday, 2011; Ndabula et al., 2013; Adzandeh et al., 2014, Ishaya et al., 2015).

In their separate studies, Kwan (2011), Akbari and Aydede (2012), Accetturo et al. (2014) and Qiang (2014) discovered that land use changes occur when people of homogenous groups migrate within the same city to live near themselves. While Plantinga et al. (2013), Frenkel et al. (2013) and Yi and Lee (2014) have proven that people intra-migrate in an urban area due to their desire for more space and accessibility promoting urban expansion and land use changes in the process.

Another prominent factor influencing land use changes is security and safety considerations. Households generally prefer to reside in more secured and safe places. The willingness by such households to pay for utility in the form of security and safety creates demands and land uses are changed to supply those demands (Vetter et al, 2013; Lee et al., 2014).

Studies by Clark (2010) and Ndabula et al. (2013) have shown that land use planning influences land use change by urban planning policies of development control and zoning. Inversely, the mass movement of people into a particular area in a city results in indiscriminate land use changes as there will be distortions of laid-down land use plans (Oluseyi, 2006; Aliyu et al., 2013; Enisan and Aluko, 2015).

The preference for areas with public utilities and good environment makes people to demand for residence in such places leading to land use change (Adebayo, 2009; Oduwaye, 2013; Ndabula, 2013; Oruonye, 2014). Huang et al. (2015), Ajibola et al. (2013) and Udoka (2014) further buttressed that fact by finding out that such desires keeps creating demand leading to increases in rental prices and subsequent land use changes.

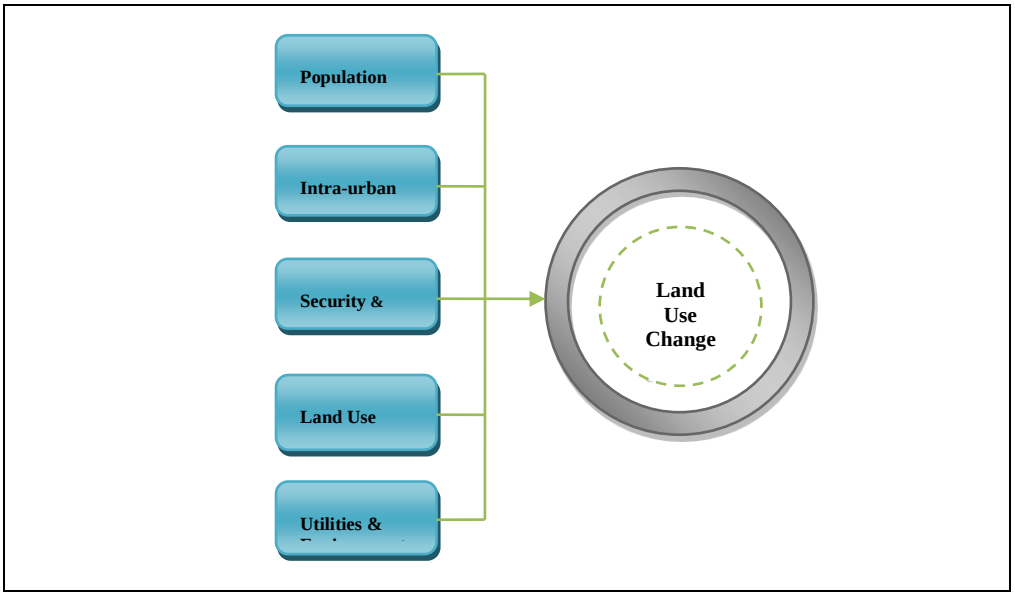

Figure 2: Factors influencing Land Use Changes and Conversion

CONCLUSION

Population increase, intra-urban migration, security and safety considerations, land use planning, and public utilities and good environment have been shown to be the major drivers of changes in land use.

The Urban Land Market Theory (Bid rent function) by Alonso (1960; 1964) is applicable in explaining the factors responsible for land use changes in different climes. It is clear that the Willingness To Pay (WTP) for utility by land users creates more demand for land use and this results to higher demand land uses crowding out lower demand ones due to inelasticity in supply of land over a short period of time. This particular situation brings about changes in land uses both legally and illegally.

Land users derive utility in different and diverse ways. Some prefer to live alongside their kith and kin, some prioritise security and safety of neighbourhoods, some have an affinity for aesthetics and well-planned locations; while others are particular about the availability and condition of public utilities and the general environment before they decide to take residence in certain places.

The identification of these drivers of land use change and conversion and their intricacies will help in terms of policy formulation to improve land use planning activities, sustainably manage land resources, reduce housing deficit and generally improve the lives of the citizens by boosting the national economy.

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Valuation of Agricultural Properties: Empirical Evidence from OXFARMS Minna, Nigeria

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Abstract:
This study aims to examine the anecdote that the Valuation Standards template for valuing specialized property, suffices for valuing a Non-Performing Agricultural Entity, NPAE. Data from a purposive case study of OxFarms and interviews with 7 practising Estate Surveying and Valuation firms and a questionnares-survey of 29 commercial Farms in Minna environs were applied using qualitative theme analysis. The main objectives are to analyse existing valuation standards template for specialized properties, and benchmarking of NPAEs, with reference to OxFarms case study. A collective grade point index, CGPI, was developed to assess and classify Farms' operational performances. The study found out and concluded that the general standards for valuing specialized property do not fully recognize the operational performance state of agricultural entities. It was recommended that the appplication of an appropriate classification model to assess the operational performance status of an identified specialized property and combined techniques of a mix of multiple bases and methods matching the purpose of valuation would provide a pathway to best practices in valuing NPAEs. By implication, this approach would potentially move valuation practice closer to the reasonable level of accuracy expected by users of valuation services.

***Keywords**: Agricultural Entity, Performance, Specialized Properties, Valuation Standards.*

1.0 INTRODUCTION

Valuing any nonperforming enterprise for sale could be challenging, primarily because the expectations gap could be so wide between the two respective parties disposing and acquiring. Thus, value and valuation become very critical to the decisions of both parties, and are dependent on entrenched constraints and circumstances. With particular reference to agricultural properties Hayward (2009) acknowledged the changing and growing nature of the challenges entailed and the fact that specialized agricultural valuation was not well documented. In recognition of the specialist nature of agricultural valuation, the Central Association of Agricultural Valuers, CAAV (2019), is set up in England, Scotland, Wales and Northern Ireland to regulate the practice notwithstanding the roles of the Royal Institution of Chartered Surveyors, RICS and International Valuations Standards Council, IVSC in the UK. A couple of literature have attempted to lay out road maps for agricultural valuation. Onyejiaka & Emoh (2014) in Nigeria and Kartomo & Aronsohn (2019) in a perspective paper for IVSC Tangible Asset and Business Valuation Boards are some examples. Also, Josiah (2016) alluded to a type of apathy by valuation surveyors in favour of urban as against rural valuation practice, in Tanzania, also apparent in Nigeria. Furthermore, Udoekanem (2012), demonstrated the use of contemporary approaches for buy-out valuations; while the author's research was based on leasehold real estate, the OxFarms case is slightly different because it is a real estate cum business interest and more importantly in a state of economic distress. None of these references, in spite of a long history of farm appraisal and valuation (Murray, 1969) focuses specifically on valuing non-performing or distressed Agricultural entity undergoing a buy-out, and so, this study seeks to lead the way in this regard.

Conceived and set up in 2013 as a multipurpose agro-allied business with requisite equipment and ancillary facilities, OxFarms in 6 years of its existence failed to achieve any major activities for which it was designed, thus it fell short of a critical element in the definition of Specialized

Property by IVSC, RICS, European Valuation Standards, EVS and Nigerian Practice Standards, NPS. In the case study, substantial real estate of over 7.0 ha and buildings, structures and ancillary facilities were acquired and developed to support a range of potential farm operations including training and agro-allied consultancy, crop cultivation, fish, poultry and feeds production, yoghurts production, meat processing, cattle breeding, fattening and sales. Thus, it is a mystery that a Farm estate of this nature and magnitude has failed thus far to achieve fulfilment: this calls for a cursory research into the raison d'être behind the non-performance as a prelude to understanding the optimal approach and best practice for valuing the entity.

From anecdotal observations, the main constraints were economic, technical and cultural in nature. Having expended huge capitals hitherto, the operators were apparently unwilling to commit further funds needed to hire qualified personnel to run the Farm professionally, as expected of such a specialized outfit where specific skills are absolutely required. As Hayward (2009) argued further, Farm enterprises are very demanding of expertise to manage. It is no surprise that the Farm remains underperforming in spite of the vast internal prospects and opportunities offered by the entity and the external market potentials for its products from within and outside Minna. Consequently, besides the risk of assets redundancy, the risks of depreciation and obsolescence are great. An underlying case of overinvestment could also be reasonably suggested by analysing rational and empirical facts in OxFarms.

The farm, which, for want of an appropriate name is referred to as OxFarm Estate, is contiguous with a Higher Educational Institution offering academic training and courses at the highest levels. Thus a special spatial relationship which may impact valuation process is prima facie established. This is buttressed by an apparent encroachment detected upon valuation inspection. This implies that the basis of value has to be chosen with greater vigilance that recognizes and respects the special relationship. A brief survey of Minna revealed a few, but growing number of, modern large farm estates that seem to be undergoing a state of economic distress the consequence of which led to the phenomenon of endemic under-performing or non-performing. The purpose of valuation is the critical starting point in any valuation exercise including agricultural assets; Onyejiaka & Emoh (2014) and Kartomo & Aronsohn (2019) are unanimous on this. The latter identify 5 purposes and the former 6; it is noteworthy that asset disposal and acquisition are listed as first. The logical activity sequence in valuation process is to establish the purpose of valuation as a prelude to adopting the appropriate basis or bases of valuation; both will provide the valuer with a clue as to the appropriate method as depicted by Fig 1.

The understanding that a general template for valuing a specialized property, would suffice for agricultural assets is open to argument. Specialized properties are diverse (Appraisal Institute, 2013) and too broad in classifications to symbolize agricultural properties which as well have their own intra-class diversities; thus, a gap still exists as to the best practices in valuing them particularly if found in under-performing states. The study aims to expose some vital underlying issues that merit due attention in the valuation of a distressed agricultural property when a buy-out is contemplated, where the possibilities of overvaluation or undervaluation exist. To achieve this aim the study examined the general template for valuing specialized properties and developed an index for assessing and classifying the performance status of agricultural entities and applied same on 29 commercial Farms including OxFarms.

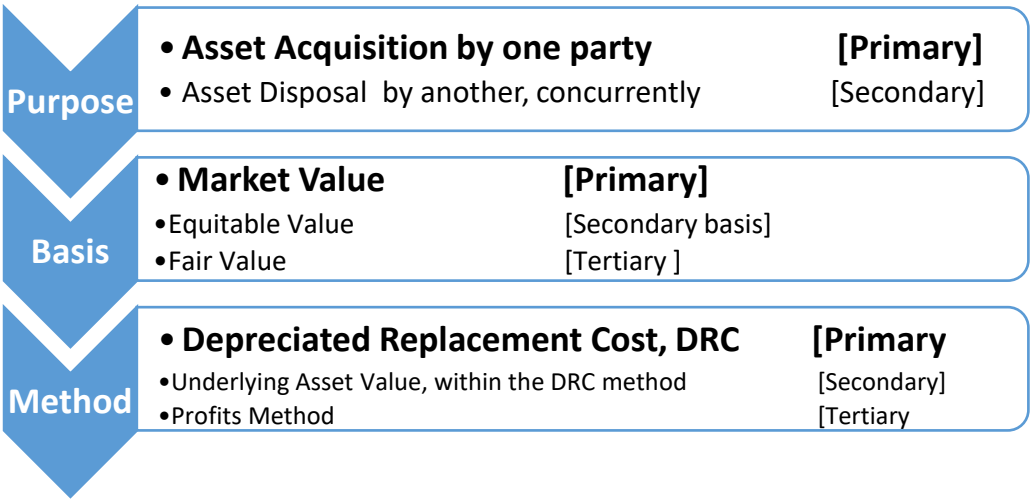

Fig. 1: Valuation Activity Sequence: Purpose, Basis and Method.
Source: Authors, 2019

Theme approach was complementarily adopted in that it allows crucial facts that impact value to be identified, as well as other underlying issues of interest that might not be so obvious without special attention, using the identified themes to address the research and interpret the data sensibly. Maguire and Delahunt (2017) affirmed the usefulness of thematic analysis for qualitative data. Defined as the process of identifying patterns and themes within qualitative data, theme analysis has advantages of not being tied to any particular epistemological or theoretical perspective, thus making it a flexible method of research where qualitative data are predominant (Clarke and Braun, 2013 in Maguire and Delahunt, 2017).

Estate Surveyors and Valuers, ESVs are data-rich sources for the property market information and constitute a primary source (Olatunji, 2010). Direct knowledge and experience of the researchers coupled with limited interview survey of some non-performing commercial agro-allied properties in Minna is also an asset in data mining for this study. The report of OxFarms valuation case study by Olatunji et al., (2019) is the main secondary data source and considered as good as a primary data source with relevant literary materials which are characteristically sparse. Agriculture entities under valuations are the population of the study. However, the population frame is virtually indeterminate probably because valuation is largely a confidential matter; owing to privity of contracted briefs, the value and valuation are hardly disclosed. In rare cases where it was disclosed that a valuation was carried out, the valuation reports could not be sighted. This explains the adoption of a purposive selection of OxFarms valuation case study. It has been argued by Ibanez and Daly (2007) that a fewer case with rich data can compensate for large samples with sparse information. Ibanez et al., (2007) found in **http://www.etcproceedings.org/paper/optimality** argued that by extracting a richer data content from each observation in a small sample (a case study), optimal results equivalent to that obtainable from a large sample can be achieved. Narratives, tables, charts are utilized to present some data and information with clarity.

A highlight of the basic contents of the case study valuation was made in Olatunji et al., (2019), wherein the techniques, approach and bases of valuation were detailed. These include the process of crunching the figures to obtain the opinion of value for acquisition of the farm estate. This present study focuses on the minimum standards set by local and global setters as well as

ideas of authors and literature with particular emphasis on agricultural properties. Then the application of the standards in the subject empirical case was demonstrated.

2.0 LITERATURE REVIEW

2.1 General template for valuing specialized properties

The term "specialized property" can be nebulous unless defined in the valuation terms set by the global valuation standard setters. Thus defined, a specialized property is one that is rarely, if ever, sold in the market, except by way of sale of the business or entity of which it is a part, due to the uniqueness arising from its specialized nature and design, configuration, size, location or otherwise (RICS, 2014; NPS, 2018). This definition is however silent about the operational performance status of the property so defined. A whole range of value attributes of a specialized property could alter when the core functions become dormant, and only a distinct class would sufficiently address them. IVSC (2017) further mentions "specialised or special-use" assets in IVS 300 Section 70 and describes how to proceed with their valuation in paragraph 70.1.

2.2 Valuation Standards

The global standards, (RICS, 2014; EVS, 2016; IVS, 2017) as well as local standards, (NPS, 2018) are unanimous that specialized properties should be valued by the depreciated replacement cost concept, DRC on existing use basis, EUV. Where evidence suggests otherwise, recourse should be made to alternative approaches. Apparently, RICS offers the most comprehensive view of SP as regards its definition, basis and method of valuation. While adopting the aforestated definition in its glossary, RICS (2014, 2017) states that an SP should be valued using the DRC approach referred to in FRS 15 as a basis. RICS (2014) offers another avenue to decide whether or not a property is a SP: the possibility or otherwise of providing only an Existing Use Value, EUV; Valuation could be done by reference to its trading potentials, (Profits method) or by logical extrapolation of any available market evidence. Though not so stated explicitly, projections ought to be based on current operational capacity. A 'no-EUV' scenario may arise either because the property is not in use at all (non-performing), or not in use for the purpose for which it is designed and constructed. The latter case is construed as alternative use implying an Alternate Use Value, AUV. The RICS further recommended the DRC method for valuing SPs with evidence of adequate potential profitability.

According to IVS 300 asset standard, the cost approach will be applied in three steps beginning with an estimate of the cost to a market participant of replacing the subject asset by reference to the lower of either the reproduction or replacement cost. The replacement cost is the cost of obtaining an alternative asset of equivalent utility, either a modern equivalent providing the same functionality or the cost of reproducing an exact replica of the asset; the details of the application are expressed in IVS 105 paragraph 70.1 to 70.14. In addition, special consideration for Real Property interest are described in IVS 300 section80. In a general overview, TEGoVA (2016) under its sub-section 6.4.1 affirms that the cost approach is the most commonly used to estimate the replacement value of SPs and other property that seldom, if ever sold or let in the market. The Nigerian valuation standards, NPS (2018), accept the positions of IVSC and RICS discussed above.

It is quite obvious from the foregoing discourse that, in defining and recommending valuation bases and methods for a SP the existing main Standards do not clearly recognise the importance of the current operational performance status in valuing an entity slated for valuation. This

means an SP is assumed to be operationally working as designed and constructed, with no clear statements that could be applied to a NPAE. Reasons for not recognizing this dimension of SPs in existing standards are not known. However one could take the risk to attribute non-recognition perhaps to the fact that only scattered references are given to SPs in all valuation Standards literature: None has treated SPs as a distinct class of assets. For example IVSC2019 Assets Standards did not offer a distinct class of assets to SP. A snapshot into the Assets Standards of RICS VPGA 1-13 and IVS 101-105 adopted by NPS (2018) shows that all the major international valuation standards setters are accountable for this omission.

A way forward is to sub-classify SPs into less heterogeneous categories based for example on their performance statuses: producing SP (PSP) or non-producing SP (NPSP), as illustrated in Fig. 2. While PSPs are in active production state and operational performance with active men, money and machine, NPSPs are not.

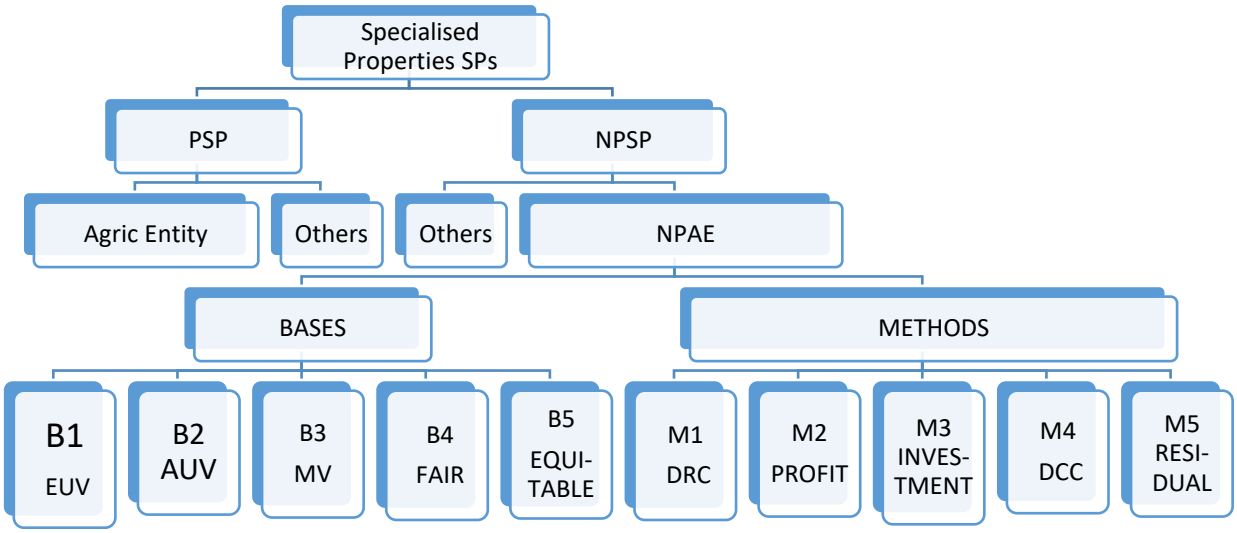

Fig 2: Existing Bases and Methods of Valuing Non-Performing Agricultural Entities, NPAEs

Key: EUV= Existing use value; AUV= alternate use value; MV= market value; DRC= depreciated replacement Cost; DCC= direct capital comparison; PSP= performing specialised property; NPSP= non-performing specialised property; NPAE= nonperforming agricultural entity.

Source: Extracted and modified from Valuation Standards

For the purpose of classification, a producing SP could be defined as one that is actively continually performing to a significant proportion of its designed capacity. Conversely, a non-producing SP lacks all the qualities of continuity, performance to capacity as defined. Thus defined, the appropriate basis and method of valuation could be explicitly chosen: Income or profit method for a Producing SP, otherwise, the DRC method. Appropriate classification therefore, should be the first step in the valuation process of an identified SP; then, the valuation would proceed as prescribed by the valuation standards being applied. From another perspective, the use of mass appraisal technique was suggested by Walt (2016), with particular emphasis on all asset components including biological assets. Olatunji et al. (2017) demonstrated the application of applied principles and ICT tools in valuing commercial properties. RICS (2016) professional guidance for UK on Farm Stocktaking Valuation is inapplicable here because it excludes fixed assets and DRC method. Only biological assets,

store and such items, which are not present in OXFARMS case, are covered. All these are different dimensions possible in valuing SPs beyond the present scope.

All the global, regional and local literature examined in this study apparently did not specifically address non-performance as classification criteria for specialised properties for the purpose of valuation. For example, Kartomo & Aronsohn (2019) focused on the adequacy of IVS for valuing agricultural and biological assets, and concluded that the standards are adequate but remain silent on performance status. The CAAV saw reasons to regulate the practice of agricultural valuation generally. On the part of Josiah (2016), rural valuation practice, including farm valuation is not popular with valuers in the east African nation of Tanzania; hence no motivation for agricultural valuations which are now being conducted by non-valuers. For Onyejiaka & Emoh (2014), the main issue is the content of agricultural valuation reports. With the exception of Boulder County, Colorado, USA, which specifies statutory criteria, all literature and Standard setters, ignore the need to offer specific guidelines for valuing non-performing entities including NPAEs. IVS, NPS and EVS remain limited to specialized properties as a broad class of assets. From the RICS (2017) perspective, the recognition of Special Purpose properties is a tacit recognition that the use and performance status are very important in the valuation of specialised properties. The gap in knowledge therefore exists to justify the development of a model for valuing NPAEs as specialised properties.

2.3 Characterization of Ox-Farms as a specialized property, SP

A superficial look into valuation practice tends to suggest that an entity like OxFarms is viewed as a specialized property, and may be valued as such without any further considerations. However, a closer observation in the case study revealed that OxFarms fulfills only parts of the attributes of a specialized property defined by RICS (2014) and adopted by NPS (2018). Table 1 is an attempt to depict this observation more clearly.

Table 1. Characterisation of OxFarms as a Specialised Property

	1	2	3	4	5	6
Specification	Design/ Construction	Configuration/arrangement	Size	Location	Performance	Others
Status as SP	√	√	√	√	×	Unclear

Source: Case Study, 2019

Key: √ = Fully met √= Partially met × = Not met

It is noteworthy that the EUV does not connote performance status as envisaged within the context of this study. Thus, failing to meet up substantially with these prescriptions, it became inevitable to apply appropriate modifications and adopt multiple bases and approaches to value OxFarms. Although IVS 105 does not impose the adoption of alternative approaches in valuation practice, special constraints and circumstances in the process of the subject exercise demanded so, principally for value-crosschecking purposes.

3.0 RESULTS

3.1 Benchmarking the Performance Statuses of Agricultural Entities through a Capacity Survey

There are a number of ways to measure the performance status of a business-oriented entity. One method adopted by Academy Treasurers (2019) is the annual financial reports like profit

and loss, assets and liability. Viewing its present state of sheer inertia, OxFarms can be anecdotally described as non-performing. However, a more appropriate method is one that can be used to assess performance relative to, and in comparison, with other businesses of its kind. Most plant and equipment have designed capacities; agricultural and non-agricultural businesses alike have maximum production capacities which can be gauged over a specific period, usually one year. For example in Colorado (US), agricultural properties are those so classified by Statue (CRS 39-1-102) for valuation purposes and productive capacity is one of the two recognized performance measurement criteria (www.bouldercounty.org). Using this method, a schedule of capacity utilization table was produced for 29 Farms studied in Minna, including OxFarms (Table 2)

Table 2: Capacity utilization survey of 29 selected agriculture and agro-allied farms in Minna environs

	Capacities of Production per annum, (Subject to max. of 3 Leading Products)									
	PRODUCT 1			PRODUCT 2			PRODUCT 3			
FARMS	**Max**	**Present**		**Max**	**Present**		**Max**	**Present**		**Mean %**
S/N	Installed	Output	%	Installed	Output	%	Installed	Output	%	1, 2, & 3
1	3000	2680	89.3	24000		0.00	-			44.7
2	45	35	77.8	3570	980	27.5	270	38	14.1	39.8.
3	120000	35000	29.2	200	89	44.5	-			36.9
4	345	224	64.9	4500	540	12.0	-			38.0
5	84	68	81.0	54000	9000	16.7	-			49.0
6	253	128	50.6	30000	2000	6.7	4500	1580	35.1	30.8
7	6700	4300	64.2	3500	2800	80.0	-			72.1
8	90200	71000	78.7	-			-			78.7
9***	220	39	17.7	125000		0.00	220000		0.00	6.0***
10	2700	1280	47.4	45000	5041	11.2	280		0.00	19.5
11	32500	22000	67.7	250		0.00	-			34.0
12*	75300	61900	82.2	-			-			82.0*
13	7580	3000	39.6	3800		0.0	410	145	35.4	25.0
14	100000	28000	28.0	-			-			28.0
15**	54000	30000	56.0	3025	300	9.9	-			33.0**
16	7800	5500	70.5	-			-			70.5
17	450	380	0.84	20000		0.00	7800		0.00	28.0
18	4500	2800	62.0	-			-			62.0
19	36000	9200	26.0	-			-			26.0
20	40	25	63.0	4500	2500	5.6	375	204	54.4	41.0
21	250000	160000	64.0	800		0.00	-			32.0
22	35000	15500	44.3	380	35	9.2	360		0.00	17.8
23	2530	1200	47.0	7080	700	9.9	-			29.0
24	45000	29000	64.0	-			-			64.0
25	8050	200	2.5	3500	870	24.9	500	210	42.0	23.1
26	2500	1540	61.6	78000	34000	44.0	-			52.8
27	65000	20500	31.5	-			-			31.5
28	5280	4300	81.0	350		0.00	450		0.00	27.0
29	7280	300	4.1	-			-			4.1
Median			62.0			10.0			14.0	33.0
Mean			54.0			19.0			18.0	38.0
SD			24.0			22.0			21.0	19.0

Note: *Best Performing Farm; **Median Performing Farm; ***Least Performing Farm

Source: Field survey, Oct/Nov 2019

A study of 29 corporate Farms in Minna produced the Capacity Utilization Schedule in Table 1. The products include fish, beef, poultry, fruits and feeds. Their productive capacities are measured as a ratio of output and installed capacities. For convenience, the respondents were restricted to maximum of 3 leading products as observations supported. Production capacities were recorded in terms of quantities such as weights (kilograms), number or, packs (sacks). The units of measurement will even-out when converted to percentiles. As shown most farms have one product, some have two while a few have three. Oxfarms occupy serial number 9*** on the Table with only one product but huge capacities for two others for which production was nil. The result is a subsequent 6.0% mean capacity performance compared to 33% for the Median Farm, (Serial 12) and the highest at 82%. The results of the analysis are transformed into an index for clearer understanding of the Farms' performance statuses in Table 3.

Table 3: Performance index measured using collective grade points of farm productions

Product	Weight	Output as % of Capacity	Grade	Point	Grade Point	Collective Grade Point	CGPI
Best Performing Farm							
P1	3	62.50	B	4	12		
P2	2	55.56	C	3	6		
P3	1	54.40	C	3	3		
	6					21	3.50
OXFARMS							
P1	3	0.00	F	0	0		
P2	2	0.00	F	0	0		
P3	1	17.73	F	0	0		
	6					0	0
Median Farm							
P1	3	69.87	B	4	12		
P2	2	0.00	F	0	0		
P3	1	0.00	F	0	0		
	6					12	2.00

Source: Extracted from field survey, 2019

In column 1 are the Products with assigned weights; each Farm is restricted to its best 3 products designated as P1, P2 and P3 with weights of 3, 2 and 1 respectively according to the level of attention and prominence it receives in the farm's Management. Actual output of a responding farm as a percentage ratio of its designed capacity was applied, with assigned weights and gradings. 6-scale grades system on A to F was matched with respective points from 5 dowwards to 0. The CGPI is obtained by dividing the total grade points by the total weight, 6. The result shows the performance indices of all Farms studied. Results of 3.5CGPI for the best Farm and 0.00 for OxFarms and a mean of 2.7 were obtained as part of the benchmarks which rated 0-1.99 as non-performing, 2.00-2.99 as low, 3.00-3.99 as moderate and 4.00-5.00 as high performing farms. Thus, it is justifiable to rank OxFarms at 0.00 as a non-performing agricultural entity, NPAE. The outcomes of Table 1 and Table 2 are also useful in assessing the potential returns of OxFarm, and the subsequent Bid Figures and Ceiling Figures for purchase negotiations.

Operating at 6.0% of its designed capacity or 0.00-0.99 on the CGPI scale of 5.00, the farm could be classified as NPAE. First, the valuer could be restricted in the choice of methodology, when it is imperative to combine methods and bases: this represents a contradictory demand

paradox. For example, the Profits method is the method of choice, first among others, when valuing a corporate commercial-oriented entity. In principle, theory and practice standards it is to take precedence over all other methods. But in reality, a NPAE lacks the basic data to support the use of Profits method, and recourse has to be made to the next-best method. It remains debatable whether the value arrived at using a secondary method could sufficiently produce the best result.

The classification model used in this study recognizes that all types of farm products (fish, dairies, fruits, grains and so on) would ultimately fit into the Best-3 pattern in terms of capacity hierarchy of products, regardless of types. Thus a Farm with many products types would certainly have its Best-3.

3.2 Benchmarking the performance status of OxFarms

For the purpose of this study, there is need for a more scientific method with benchmarks for assessing organizational performance more objectively through an index. No satisfactory operational performance measurement index for a multi-product establishment could be found as most available are used for single-product farms. Patterned in the form and functions of CGPA used to assess a student's overall performance at most Universities worldwide, the collective grade point index, CGPI was developed and used with modifications as a performance measurement index depicted in Table 3. The table revealed that the best performing Farm has a CGPI of 3.50 while the Median Farm is indexed 2.0. The comparative CGPI of 0.00 clearly reveals the non-performing status of OxFarms more vividly than does a percentile in Table 2. The valuation will proceed with OxFarms appropriately classified as a NPSP, which NPAE is a subset of.

4.0 FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

A whole range of scenarios emerged and altered where the agricultural property identified as a Specialised Property laid redundant, underperforming, outrightly non-performing or operationally inactive for a substantial period of its existence.

4. Based on empirical survey of similar commercial bodies in Minna, and beyond mere conjecture and visualization, OxFarm is classifiable as a non-performing Agricultural entity. Only an empirical research involving its competitors could reveal the true activity-status of performance of a commercial entity, slated for valuation for the purpose of classification as NPAE.
5. It is appropriate to value OxFarms as a specialised property with identified peculiar characteristics, the result of its non-performing status.

Dwelling on these major findings, it is concluded that

6. The general DRC template for valuing SPs needs to be tinkered with, in order to arrive at an appropriate approach to valuing NPAEs. More specific and restrictive bases and methods of valuation are required for valuing SPs rather than the general template prescribed by most Valuation Standards.

In the valuation of NPAEs, this paper puts forward a 2-pronged approach founded on any appropriate classification model (ACM) and applying a mix of multiple bases and methods, (MMBM). The following recommendations are made upon the findings and conclusion:

7. Using an appropriate assessment index, an identified SP slated for valuation should first be graded to justify classification or otherwise as a NPAE, by any ACM.
8. To value a Specialised Property certified as a Non-Performing Agricultural Entity, valuers should adopt multiple bases and methods MMBM, as may be deemed appropriate.

The implication of this findings is that the application of this approach may move valuation practice closer to the reasonable level of accuracy is expected by users of valuation services.

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Application of Electrical Resistivity Method to Delineate Construction Sites at Gidan Kwano Campus, FUT, Minna, Niger State, Nigeria

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Abstract:

Vertical Electrical Sounding (VES), using ABEM SAS 4,000 Terrameter was carried out on a 500 x 500 m area of land located between latitude 09°32'21.4" N to 09°32'37.8" N and longitude 06°27'29.2" E to 06°27'45.5" E at the northern part of Gidan Kwano Campus, Federal University of Technology, Minna, Niger State. The study was aimed at investigating the subsurface structures of the study area with a view to delineating the sites suitable for civil engineering work. A total of 36 VES points at 100 m interval were sounded with a 100 m maximum half inter current electrode spacing (ab/2). Result revealed that the study area is underlain by three (3) geoelectric/geologic layers which include: the top soil with 10.6 to 1679.8 Ωm, 0.5 to 4.2 m and 0.5 to 4.2 m as its range of resistivity, depth and thicknesses respectively; the weathered layer having resistivity of 4.8 to 61.5 Ωm, depth of 2.7 to 23.0 m and thickness of 2.1 to 21.1 m; and the fractured/fresh basement which has 158.7 to 1421.5 Ωm as its resistivity value with undefined depth and thickness. The observed curve types include: A (3%) and H (97%). The points delineated for civil engineering works are VES stations A6, B1, B6, C5 and F1 having shallow depth to basement.

Keywords*. Resistivity, Basement, Depth, Geoelectric layer.*

INTRODUCTION

The growth of any community is highly dependent on the availability of infrastructures like roads electricity and industries among others (Salako *et al*., 2010) and according to Nnamdi, 2010, there are three important requirements for human survival, they are Food, Clothing and Shelter. Well-structured shelter is of significant importance to Nigeria where building collapse has become a familiar occurrence (Alamu and Gana, 2014). Due to improper site investigation and poor foundation, there have been several cases of building collapse in Nigeria for some decades now (Alhassan *et al.*, 2015); according to Alamu and Gana, 2014, Nigeria recorded the highest report of structural failures between 1980 and 2014. It has resulted to the loss of several lives and valuables over the years.

Vertical electrical sounding (VES) was employed to investigate the competence of the subsurface layers of the study area for civil engineering activity. Improper founding of foundation and substandard quality building materials have been the most cause of structural failure (Akintorinwa & Abiola, 2011). Sitting buildings on incompetent earth layers also affects buildings aside design error (Alhassan *et al*., 2015). A good foundation should sustain structures erected on it in such a way as not to cause any damage to the whole or part of a building due to earth movements or vibrations.

Electrical resistivity method is widely used in preliminary site investigation to show the materials existing in the subsurface (Omowumi,2014).

The study area is located at the northern part of the Gidan Kwano Campus, Federal University of Technology, Minna. It is defined by latitude 09°32′21.4″N to 09°32′37.8″N and longitude 06°27′29.2″E to 06°27′45.5″E. The population of staffs and students are increasing within the campus as more faculties are being relocated from the Bosso campus to Gidan Kwano campus, consequently, more buildings are being built to accommodate the growing population of the area. As such, there is need to delineate the areas where the fresh basement

has shallow depth and high resistivity values which can provide strong base for building construction.

Several geophysical methods have been employed over the years in determining the depth to basement, electrical resistivity method is the most effective (Alhassan *et al*., 2017). It is a reliable and an effective tool in probing into the earth's interior, its advantages includes non-destructive effect on the environment, cost effectiveness, rapid and quick survey time and less ambiguity in analysis and interpretation of data. (Todd, 1980). The Vertical Electrical Sounding (VES) technique provides information on the vertical variation in the resistivity of the subsurface layers with depth (Obiora *et al*., 2016). Wide variety of problems like determination of depth, thickness and boundary of aquifer can be solved using the vertical electrical sounding (Bello & Makinde, 2007).

GEOLOGY OF THE STUDY AREA

The study area is located at the northern part of the Gidan Kwano Campus, Federal University of Technology, Minna. It is defined by latitude 09º32′21.4″N to 09º32′37.8″N and longitude 06º27′29.2″E to 06º27′45.5″E. The study area (Minna) is underlain by Basement Complex rocks consisting of medium-grained biotite granite interbanded with coarse-grained leucocratic granite and intruded in places by quatzo-feldspar pegmatite dykes. The dykes strike parallel to the strike of the foliation, and they range from 0.5 m to 3.5 m in diameter. Outcrops are found along the river valleys as flat-lying bodies. They range in sizes from 3x5 m to about 8x15 m. Pinkish feldspar (i.e potassium feldspar) is the dominant mineral in the granite gneiss and the pegmatite. This implies that its weathered product will be rich in clay.

The rock types present in the area are part of the old granitic suite which are mostly exposed along the stream channels (Udensi *et al.*, 1986).

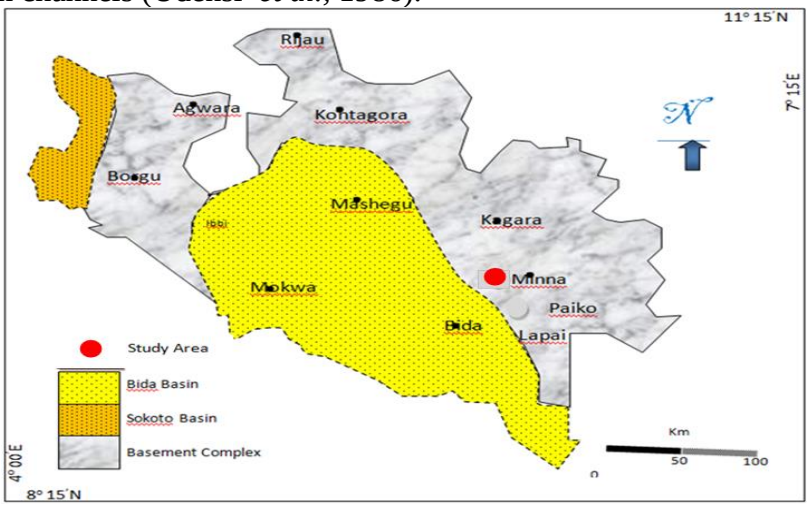

Figure 1: Geological Map of Niger State (Amadi *et al.*, 2012)

METHODOLOGY

The research employed the electrical resistivity method in delineating the shallow consolidation basement of the study area. Thirty six vertical electrical sounding (VES) points were probed using ABEM SAS 4000 model Terrameter and its accessories. Schlumberger array electrode configuration pattern with half inter current electrode spacing (AB/2) varying from 1 to 100 m was adopted. The apparent resistivity was computed using equation 1

$$\rho_a = KR \quad (1)$$

where ρ_a is apparent resistivity, R is the earth`s resistance and K is a geometric factor expressed as

$$K = \pi\left(\frac{\left(\frac{AB}{2}\right)^2 - \left(\frac{MN}{2}\right)^2}{MN}\right) \quad (2)$$

where AB is inter current electrode spacing and MN is inter potential electrode spacing.

The apparent resistivity values obtained were plotted against AB/2 using winResist software and from the plots; the resistivity, depth and thickness of each of the subsurface layer were deduced; also, geologic cross sections were made.

Table 1: Ranges of resistivity of various rocks component in basement complex (Esimai, 2017).

Rock Type	Range of Resistivity (Ω m)
Famada loam	30-90
Weathered laterite	150-900
Fresh laterite	900-3500
Granite	$300\text{-}10^5$
Alluvium and sand	10-800
Quartzite (various)	$10 - 2 \times 10^8$
Weathered basement	20-500
Fractured basement	500-1000
Fresh basement	> 1000

RESULTS AND DISCUSSION

The Geoelectric section (VES curve) as shown in Figure 1, provides information about the subsurface layer resistivity, depth and thickness as summarised in Table 2.

Table 2 shows the summary of results obtained from each geoelectric and geologic section (Fig. 3) and (Fig. 4) respectively across profile A to F which reveals that the study area is underlain by three (3) geoelectric subsurface layers. The first layer which is the top layer has resistivity value ranging from 10.6 – 1679.8 Ωm, its depth and thickness varies between 0.5 – 4.2 m and 0.5 – 4.2 m respectively which corresponds to the geoelectrical parameters of fadama loam, weathered laterite and fresh laterite (Table 2). The second layer has resistivity value of 4.8 – 61.5 Ωm, depth of 2.7 – 23 m and thickness of 2.1 – 21.2 m; this layer refers to the weathered/fractured basement. The resistivity of the third layer ranged from 158.7 – 1421.5 Ωm, its depth and thickness are undefined.

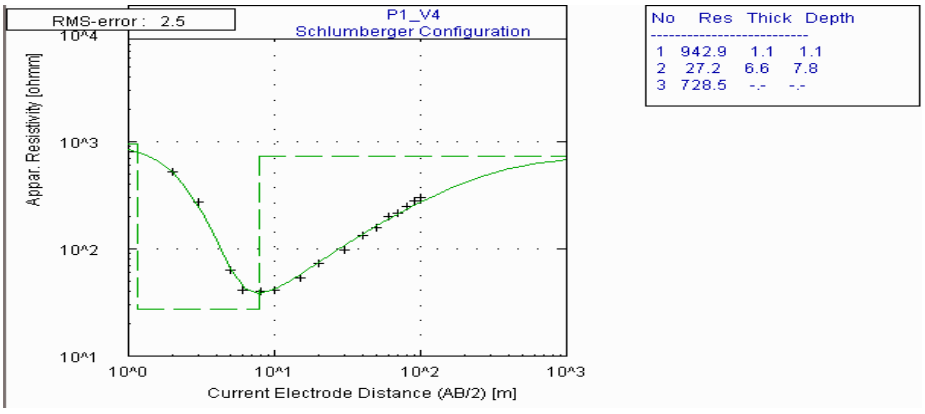

Figure 2: Geoelectric section of VES point A_4

The observed frequencies in curve types include 97% of H and 3% of A. The weathered/fractured layer in the H-curve type is usually characterized with low resistivity value made up of clayey or sandy clay (Olorunfemi *et al*. 1999).

In basement complex terrain, areas with fresh basement layer depth less or equal to 4 m are favourable and good for building construction (Alhassan *et al*., 2015)

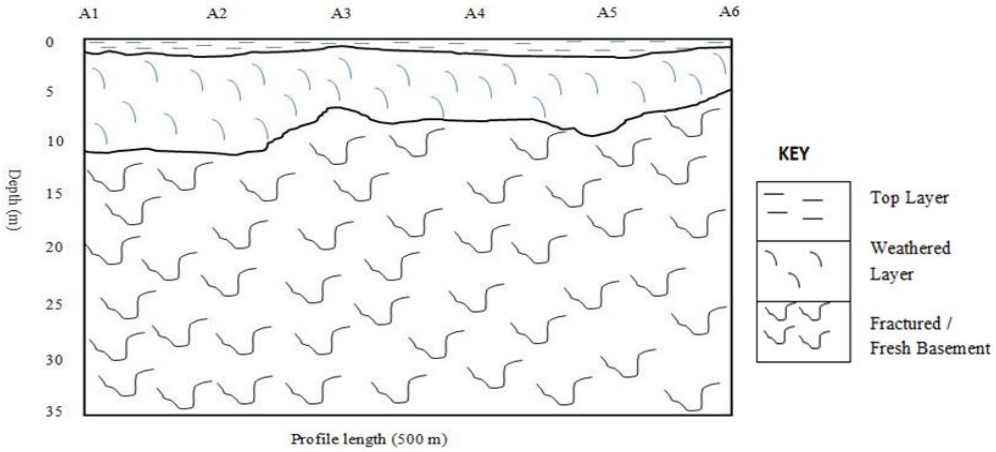

Figure 3a: Vertical Geologic section through profile A

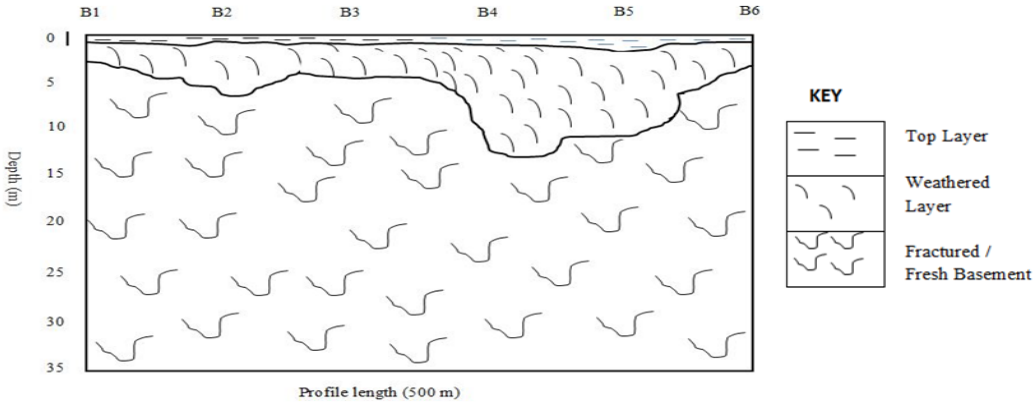

Figure 3b: Vertical geologic section through profile B

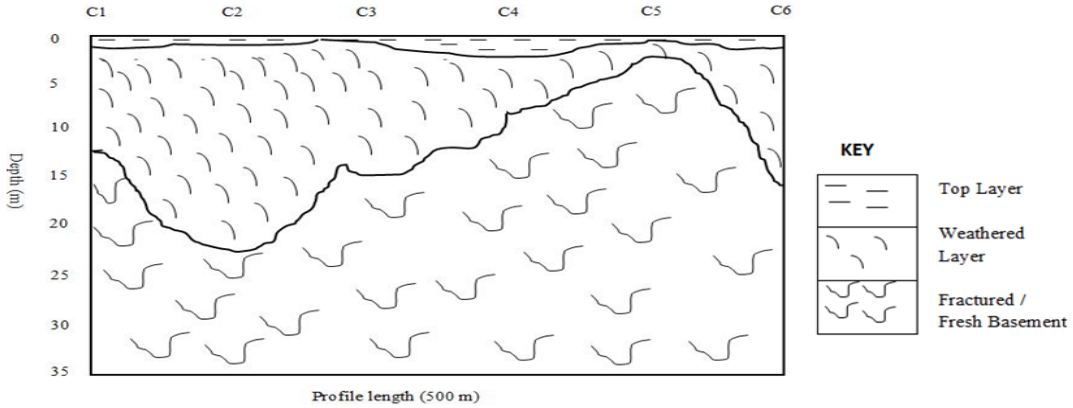

Figure 3c: Vertical geologic section through profile C

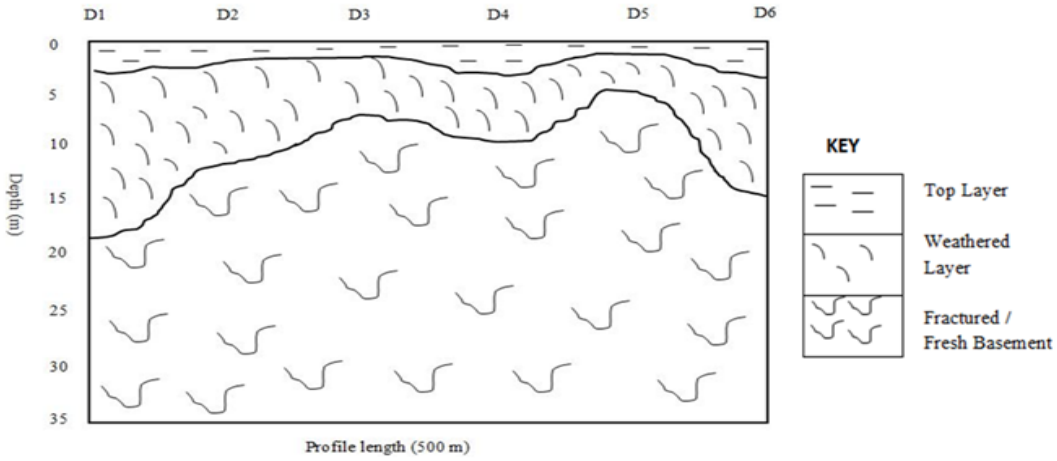

Figure 3d: Vertical geologic section through profile D

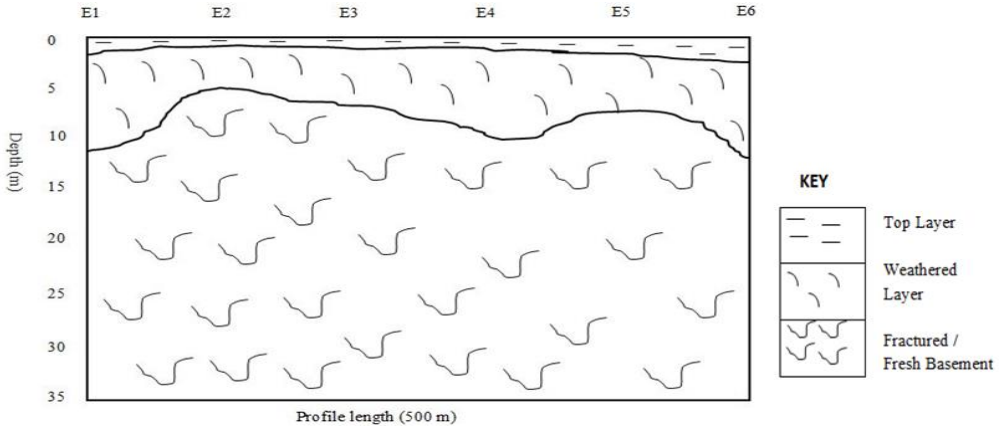

Figure 3e: Vertical Geologic section through profile E

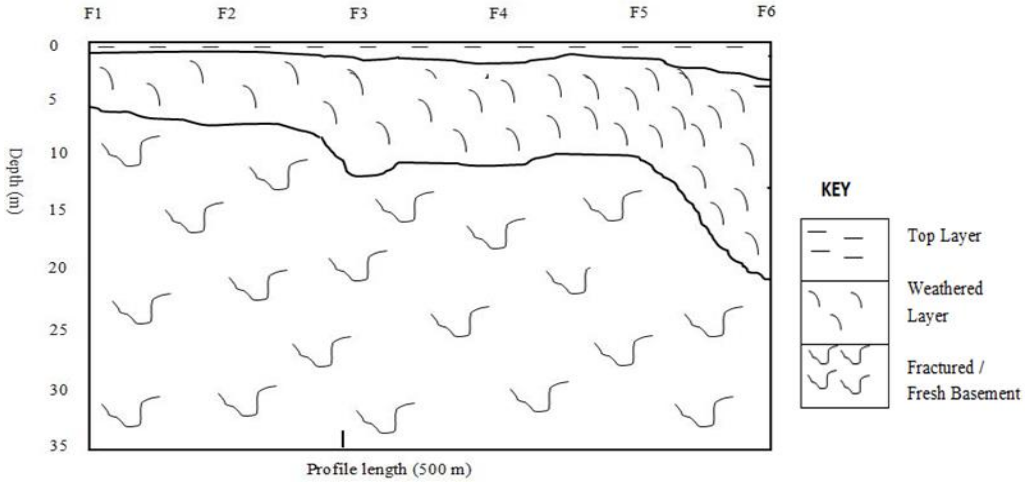

Figure 3f: Vertical Geologic section through profile F

Table 2: Layer resistivity, depth thickness and curve type

VES Stations	Latitude (°)	Longitude (°)	No. of Layers	Layer Resistivity, ρ (Ωm)			Layer Depth, d (m)			Layer Thickness, h (m)			Curve Type
				$\rho 1$	$\rho 2$	$\rho 3$	$d1$	$d2$	$d3$	$h1$	$h2$	$h3$	
A1	9.539274	6.458113	3	663	42.5	379.6	1.0	11.2	∞	1.0	10.2	∞	H
A2	9.539280	6.459023	3	564.9	40.2	821.8	1.2	10.6	∞	1.2	9.5	∞	H
A3	9.539287	6.459933	3	1188.8	23.4	904.1	0.7	6.5	∞	0.7	5.8	∞	H
A4	9.539294	6.460844	3	942.9	27.2	728.5	1.1	7.8	∞	1.1	6.6	∞	H
A5	9.539300	6.461754	3	509.5	27.4	511.6	1.2	9.2	∞	1.2	8.0	∞	H
A6	9.539307	6.462664	3	294.1	14.0	956.7	0.7	5.5	∞	0.7	4.8	∞	H
B1	9.540177	6.458106	3	416.8	4.8	936.1	0.6	2.7	∞	0.6	2.1	∞	H
B2	9.540184	6.459016	3	190.0	19.8	572.9	0.5	8.3	∞	0.5	7.8	∞	H
B3	9.540191	6.459927	3	38.1	17.1	639.0	0.7	3.9	∞	0.7	3.2	∞	H
B4	9.540197	6.460837	3	822.1	34.3	621.7	0.9	13.0	∞	0.9	12.1	∞	H
B5	9.540204	6.461747	3	691.8	34.4	870.1	1.6	11.7	∞	1.6	10.0	∞	H
B6	9.540211	6.462658	3	50.5	11.8	1421.5	0.7	3.9	∞	0.7	3.2	∞	H
C1	9.541081	6.458099	3	675.3	21.9	341.0	1.1	12.9	∞	1.1	11.8	∞	H
C2	9.541088	6.459010	3	140.3	24.2	673.6	1.7	23	∞	1.7	21.2	∞	H
C3	9.541094	6.459920	3	321.6	30.2	553.7	2.8	15.1	∞	2.8	12.3	∞	H
C4	9.541101	6.460830	3	177.2	16.7	963.0	1.4	9.1	∞	1.4	7.7	∞	H
C5	9.541108	6.461741	3	78.1	8.7	851.1	0.5	3.4	∞	0.5	3.0	∞	H
C6	9.541114	6.462651	3	68.9	61.5	463.3	0.9	16.8	∞	0.9	15.8	∞	H
D1	9.541985	6.458093	3	581.5	32.8	1236.5	2.4	18.6	∞	2.4	16.1	∞	H
D2	9.541991	6.459003	3	387.1	17.6	697.2	1.5	11.8	∞	1.5	10.3	∞	H
D3	9.541998	6.459913	3	322.3	17.3	219.2	1.0	9.6	∞	1.0	8.6	∞	H
D4	9.542005	6.460824	3	97.1	18.4	796.5	3.5	11.8	∞	3.5	8.4	∞	H
D5	9.542011	6.461734	3	97.6	17.4	381.1	0.9	6.0	∞	0.9	5.2	∞	H
D6	9.542018	6.462644	3	387.8	29.3	708.3	3.3	14.3	∞	3.3	11	∞	H
E1	9.542888	6.458086	3	447.0	24.9	158.7	1.4	11.6	∞	1.4	10.2	∞	H
E2	9.542895	6.458996	3	113.6	13.9	163.4	0.5	6.6	∞	0.5	6.1	∞	H
E3	9.542901	6.459907	3	18.5	13.5	769.8	0.8	7.4	∞	0.8	6.6	∞	H
E4	9.542908	6.460817	3	165.9	20.8	583.3	0.9	13.0	∞	0.9	12.2	∞	H
E5	9.542915	6.461727	3	871.2	17.7	692.2	1.9	8.2	∞	1.9	6.3	∞	H
E6	9.542921	6.462637	3	221.5	31.3	1138.8	2.8	13.2	∞	2.8	10.4	∞	H
F1	9.543792	6.458079	3	10.6	19.1	338.4	1.0	5.2	∞	1.0	4.2	∞	A
F2	9.543798	6.458990	3	296.7	15.8	312.2	0.6	7.3	∞	0.6	6.7	∞	H
F3	9.543805	6.459900	3	1679.8	27.5	579.2	1.2	12.4	∞	1.2	11.2	∞	H
F4	9.543812	6.460810	3	210.3	18.7	355.9	1.9	12.0	∞	1.9	10.0	∞	H
F5	9.543818	6.461720	3	848.0	22.4	763.5	1.4	9.9	∞	1.4	8.5	∞	H
F6	9.543825	6.462631	3	793.1	39.2	474.3	4.2	20	∞	4.2	15.8	∞	H

Iso-resistivity map (Figure 4) were also obtained for the layers using the Golden Surfer software in order to investigate the continuous variation of resistivity with depth. An interval of 100 Ωm was used to generate the iso-resistivity contour of the first layer (Figure 4a). The range of the resistivity values is 10.6 to 1,679.8 Ωm. The areas with the lowest resistivity value trends from northwest to southeast with an extension towards southwest, it is characterised by fadama loam, sand and gravel; while those with high resistivity value are at the northern and southern parts.

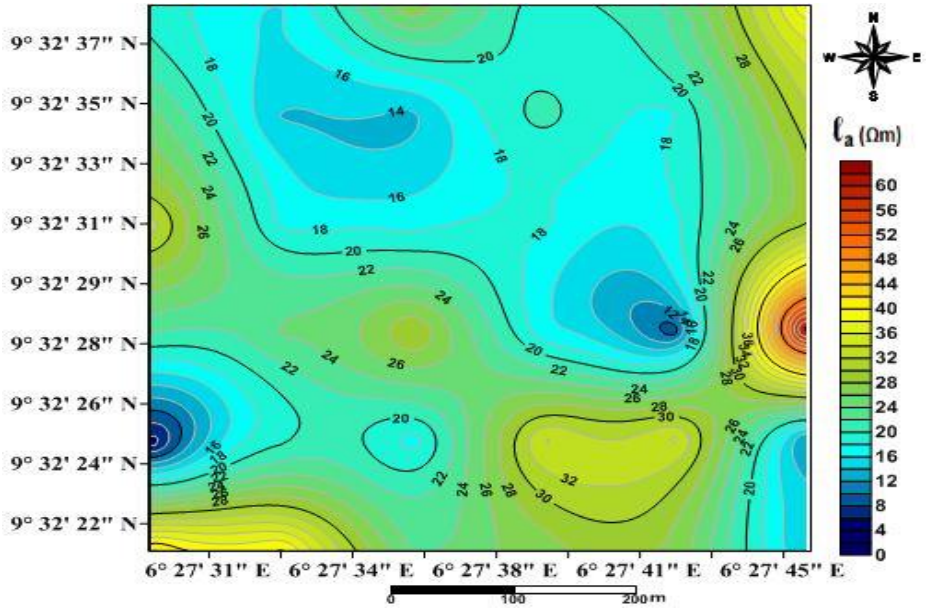

Figure 4a: Iso-resistivity contour map of the first layer

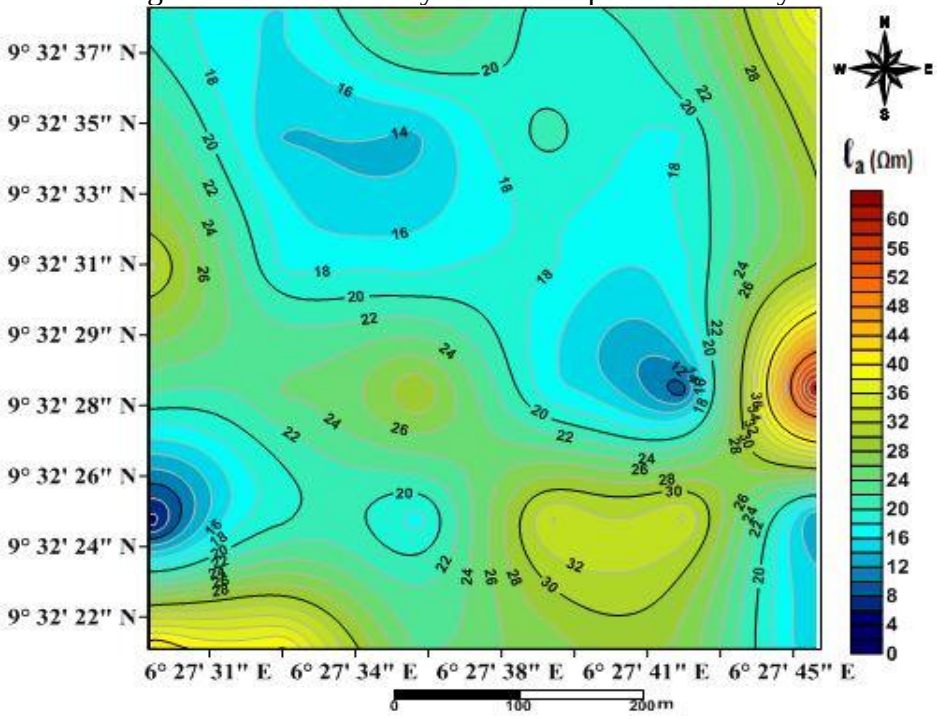

Figure 4b: Iso-resistivity contour map of the second layer

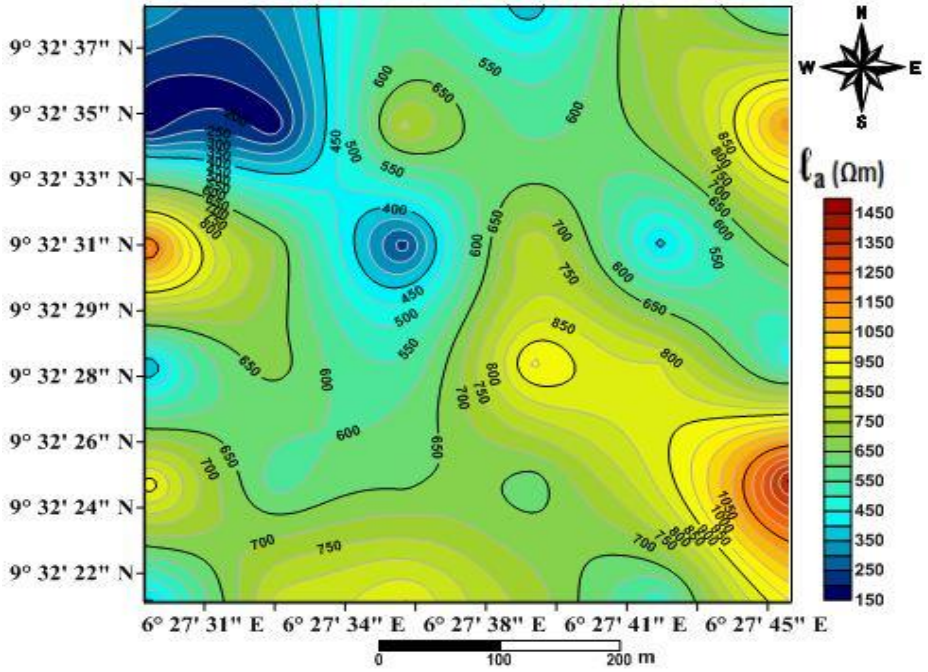

Figure 4c: Iso-resistivity contour map of the third layer

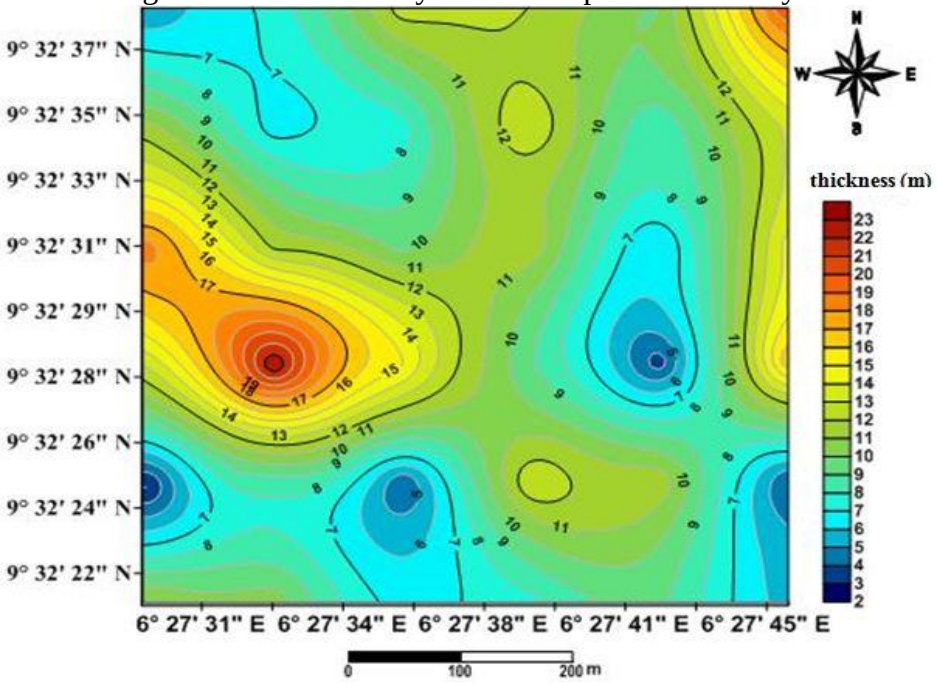

Figure 4d: Overburden contour map of the study area.

The iso-resistivity contour of the second layer (Figure 4b) was generated at an interval of 4 Ωm. The contour shows that the resistivity of the weathered/fractured zone is higher at the northeastern, eastern and southern part of the study area while the northern and central part are characterised by lower resistivity value. The iso-resistivity contour of the third layer (Figure 4c) reveals that the study area is highly weathered/fractured. The contour was generated at 100

Ωm interval with resistivity values ranging from 158.7 to 1421.5 Ωm. The third layer has its lowest resistivity value majorly at the north-western part of the study area while those of high resistivity occupy the north-eastern, south-western and south-eastern parts. The Isopach (overburden contour map) was generated at an interval of 1 m, the values range from 2.7 to 23 m as shown in Figure 4d. The contour reveals that overburden thickness is higher at the north-eastern and west-central parts of the study area while the north-western, southern, south-eastern and south-western parts are of lower overburden thickness.

Table 3: Recommended points for civil engineering works

VES Station	Latitude( )	Longitude( )	Number of layers	Depth to basement
A_6	9.539307	6.462664	3	5.5
B_1	9.540177	6.458106	3	2.7
B_6	9.540211	6.462658	3	3.9
C_5	9.541108	6.461741	3	3.4
F_1	9.543792	6.458079	3	5.2

The sites suitable for structures within the study area were delineated after careful consideration was given to the resistivity, depth and thickness of the subsurface layers, five VES points having depth to fresh basement varying between 2.7 to 5.5 m were chosen; the points are: A_6, B_1, B_6, C_5 and F_1 as shown in Table 3.

CONCLUSIONS

The results obtained from the analysis of the data acquired in field of survey clearly showed that the electrical resistivity method is suitable for and very efficient in investigating the parameters of the subsurface structures. The study area is characterised by three (3) geoelectric layers as clearly revealed by the result, they are: the top layer which consist of fadama loam, sand and gravel; weathered layer and the fractured/fresh basement layer.

The resistivity of the top layer, weathered layer and fractured/fresh basement layer varies from 10.6 to 1,679.8 Ωm, 4.8 to 61.5 and 158.7 to 1,421.5 Ωm respectively across the entire study area; the depth of the top layer ranges from 0.5 to 4.2 m, that of the weathered layer varies from 2.7 to 23.0 m while that of the fractured/fresh basement layer is undefined across the six(6) profiles investigated; also, the study area has 0.5 to 4.2 m and 2.1 to 21.2 m as the thickness of its the top layer and weathered layer respectively, the fractured/fresh basement layer has an undefined thickness. Government and estate developers who wish to site structures within the study area should consider VES points A_6, B_1, B_6, C_5 and F_1. Quality excavation work should be carried out if structures must be built anywhere within the study area aside the afore mentioned points, more research work in this area would contribute immensely to solving the problem of building collapse completely.

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Computational Fluid Dynamics (CFD) Investigation of Pressure Drop across Highly Porous Metallic Structure

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Abstract

The study critically investigates the pressure drop developed across highly porous metallic structures via tomography datasets and Computational Fluid Dynamics (CFD) modelling and simulation. This study simply provides an insight into the determination of pore structure and flow information of microcellular structure for flow regimes ranging from transverse Darcy to Turbulent. In addition, permeability (K), form drag coefficient (C) and Forchheimer coefficient (C_F) was determined accurately by Darcy expression (Re <1) and Forchheimer expression (Re>1) respectively.

Keywords: Porous metals, Pressure drop, Modelling and Simulation.

INTRODUCTION

In recent year, studies involving fluid flow through porous material especially those from metals and metal alloys have attracted a wider range of attention in various field of science, engineering, environmental and industrial application. These include filters for high-temperature gas and fluid filtration, oil and gas, biomedical devices, thermal exchanger in heat exchanger, aero-engine fluid systems, and catalytic-reactor for conversion of toxic gases, load-bearing and vibrational control devices. Porous metal is suitable for these applications due to its essential properties like; high surface area, effective thermal conductivity, low density, high stiffness, good energy/sound absorption and high heat resistance (Zhong, 2013; Torre et al, 2014; Oun and Kennedy, 2014; Carvalho et al, 2017; Ahmed et al, 2018; Otaru et al., 2019).

A lot of study on various effects in solving problem concerning porous metals was attempted, but accurate modelling behaviours of pressure drop/gradient is a major concern. A survey from literature stated that studying and then controlling pressure drop across porous metals is an important factor for optimising the function of these structures and to create a new structure with improved properties (Kennedy, 2012; Dukhan, 2013; Ranut et al, 2014; Otaru et al., 2018). Analogous research work reported that pressure drop developed across these structures depends mainly both on the fluid properties and on the permeability of porous metal, which is influenced by the porosity, cell size and morphology of the pores and pore network (Choe, 2004; Dukhan, 2006; Oun and Kennedy, 2014).

Balayo (2016) also reported that the passage of fluid freely through porous material is a simple definition of permeability. In addition, permeability is dependent on the structural nature of material, that its, it's porosity and packing arrangements.

Notwithstanding, applicable theory exist between porous metallic structures and packed beds (Despois and Mortensen, (2005); Oun and Kennedy, (2014); Kouidri and Madani, (2016); Otaru, (2019)). Fluid flow with very slow velocity, characterized by pore diameter Reynolds number (R_{ED}) lees one (Re <1), the acknowledged Darcy's law relates the fluid velocity and unit pressure drop developed across porous structures (Eqn 1). Fluid flow with high velocity, the Darcy-Dupuit-Forchheimer (Eqn 2) model relates the defined pressure drop per unit flow thickness (∇p) developed across porous materials as a function of the two most important

parameters used to describe flow behaviour at very low (permeability,k_o) and high (Form drag coefficient, *C*) superficial fluid velocities (v_s), fluid dynamic viscosity (η)and fluid density (ρ).

$$\nabla p = \frac{\eta}{k_o} v_s \quad \text{(Eqn 1)}$$

$$-\frac{\partial p}{\partial x_i} = \nabla p = \frac{\eta}{k_o} v_s + \rho C v_s^2 \quad \text{And} \quad C = \frac{C_F}{\sqrt{k_o}} \text{(Eqn 2)}$$

Despois and Mortensen (2005); Kouidri and Madani (2016); Otaru et al. (2018); Otaru (2019) performed an experimental study on pressure gradient across porous metallic structure using above equations to calculate the permeability and form drag coefficient of flowing fluid through this structure and also been proved for proper knowledge and evaluating the effect of pore related parameters and structural nature of fluid flow across porous metals. Accurate computational fluid dynamics (CFD) modelling and simulation of airflow across porous metal give a very less cost and time safe compared to experimental measurement of complex equipment setup associated with measuring pressure drop built within the material. The work aims to critically investigate the pressure gradient/pressure drop of airflow across commercially available high-density porous metallic structures (Porvair™, Inconel™ and Recemat™) via X-ray computed tomography datasets. This would help in providing insights into the flow information of samples at the pore-level using computational fluid dynamics (CFD) modelling and simulation.

The CFD modelling and simulation procedure for airflow across porous metals was Performed using Comsol Multiphysics 5.2™ software package within the fluid flow – single-phase – stationary domain module. The following steps were used in the process, namely; definition of pore structure-related parameters and fluid properties, geometry, material selection, choice of physics and appropriate boundary condition, meshing dependence study and finally solving. Tomography datasets of Porvair 7PPI, Inconel 450µm, Inconel 1200µm, Recemat-MXC 1723 and Recemat-MXC 1116 porous metallic sample with voxel dimensions ranging from 12µm to 26µm were analyzed by AZeiss Xradia Verse XRM-500 3D X-ray CT system.

The pore related parameters of the structures and the properties of the fluid were well expressed and defined in the global definition of model builder. The images of the structure were imported from the Comsol file of the image to the model builder as a geometry measurement with inbuilt air as the chosen material (converted from structural domain to fluid domain). A linear-tetrahedral mesh with minimum edge length of 2.7 x voxel dimensions, maximum edge length of 6.5 x minimum edge length and growth rate of 1.3 was used to utilise the optimum mesh density ranging between 2.5-3.5 M cells for all the samples. Hence accurate and detail information of the pressure gradient/drop and velocity were determined with help of mesh density generated and computed values. Selection of flow equation and appropriate boundary condition were chosen from the physics in the model builder of package. The flow equation used in resolving the flow types was selected basically on the Reynolds number (Re); Creeping flow (Re < 1) was resolved using stokes equation while neglecting inertial effect, Laminar flow (1 < Re < 300) was resolved using Navier stokes equation, and finally Spalart Allmaras Reynolds Average Navier-Stokes (RANS) with (k-ε) model for resolving flow in turbulence (Re > 300) which was described in (Lage et al, 2005). The boundary condition was assumed that the inlet velocity was selected ($v = v_0$), pressure was constant at the outlet boundary (pressure of atmospheric condition), no-slip on the solid walls of the structures (v = 0) and

there is a symmetry boundary along the symmetry planes and the velocity perpendicular to the plane of symmetry is zero similar to that of (Henry, 2007). Solver was the final process of the model which enables studying of velocity and pressure drop streamline, arrow plot direction, convergence and data generation (result).

Presenting the results obtained from the CFD investigation of airflow across the available commercially porous metals, Fig.1 is the presentation of 3D and 2D velocity and pressure streamlines and arrow plot direction from the entrance and exit. These show how the airflow within the pores structure of RCM-NCX 1723 PPI in laminar regime and a colour legend on the map indicating the expansion and reduction of the flow. Observably, there is a built-up velocity within the connecting pore "window" which result to a large pressure drop in that zone and these was due to pore velocity is more than that of the superficial inlet velocity. These confirmed and validate the reliability of Darcy expression (Whitaker (1986); Otaru et al, (2019)).

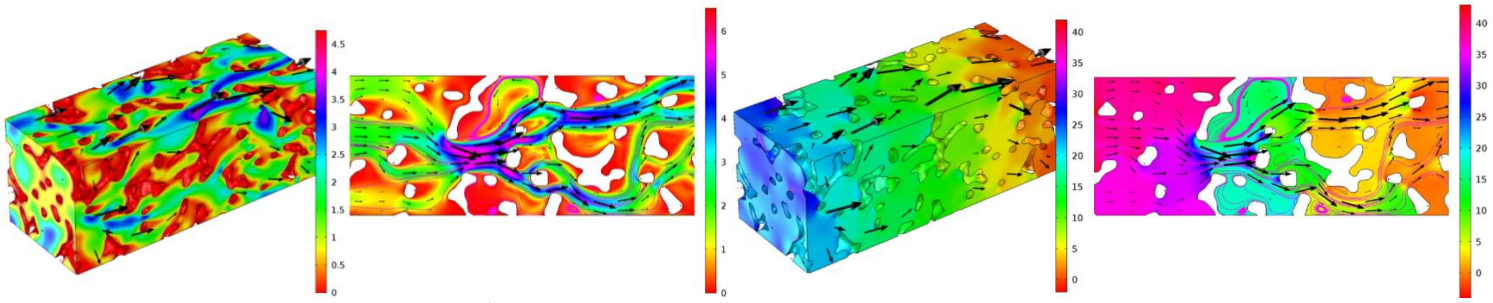

Fig 1: 3D and 2D Velocity ($m.s^{-1}$) and pressure (Pa) streamline plots of fluid flow across RCM-NCX Foam sample at Laminar superficial fluid flow velocity of 1.0$m.s^{-1}$ (R_{ED} = 122.753).

Fig 2 shows the plot of unit pressure drop of airflow across all the samples against the superficial inlet velocity ranging from (0 – 6$m.s^{-1}$). Fig 3 presents the same plot to that of fig 2 but excluding Inc. 450µm sample for clear understanding. Tab.1 presents the pore related parameters and flow information calculated by substituting velocity and pressure data acquired from the CFD simulation into Eqn. 1 and Eqn. 2. It is observed from fig 2 that Inc. 450µm sample has the highest pressure drop while RCM-NXC 1116 with the lowest pressure drop. By characterisation, Inc. 450µm with lowest pore diameter and window diameter while RCM-NXC 1116 with the highest pore diameter and window diameter. The larger the pore size the lower the pressure drop and the lower the pore size the larger the pressure drop similar to (Carvalho et al, 2017). The plot show a good curve fit of polynomial graph which indicates different regime (Darcy – Turbulent). Fig 4 indicates that for a very low fluid illustrated by R_{ED} less than unity, the correlation between the fluid velocity and pressure gradient/drop is linear (justifying the application of the local geometry to dictate the flow field at this purely viscous Darcy regime (Champoux and Stinson, 1992; Otaru et al, 2019). Tab. 1 shows that increasing pore size also increases permeability and form drag decreases while permeability is a dependent of the structural nature of the material (Balayo, 2016).

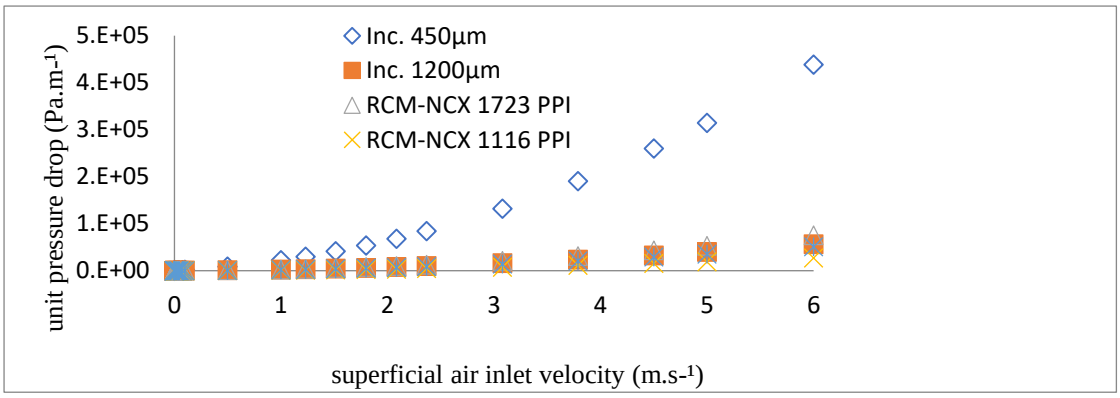

Fig.2. Plot of unit pressure drop (Pa) against superficial inlet velocity (m.s-1) of five porous structures.

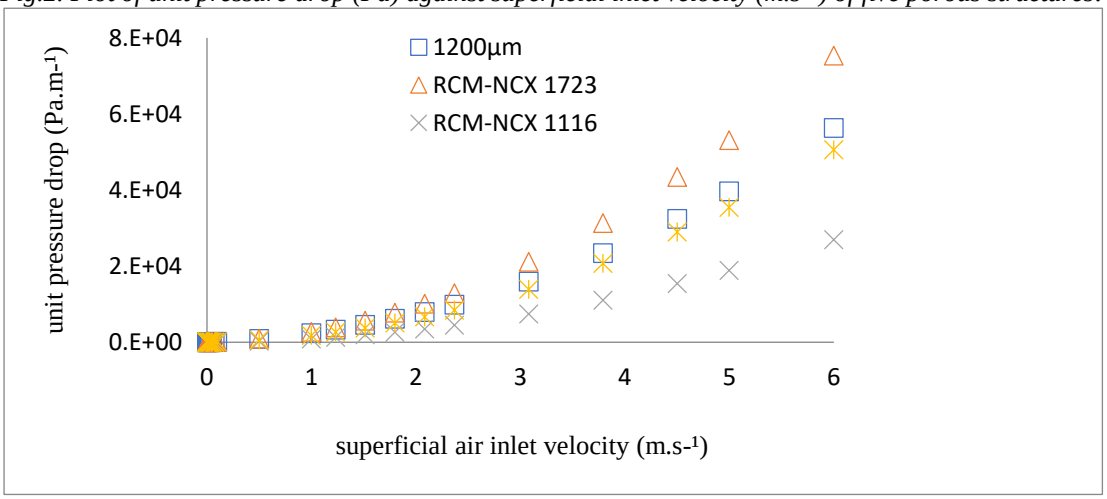

Fig.3. Plot of unit pressure drop (Pa) against superficial inlet velocity (m.s-1) of four porous structures excluding (Inc. 450µm).

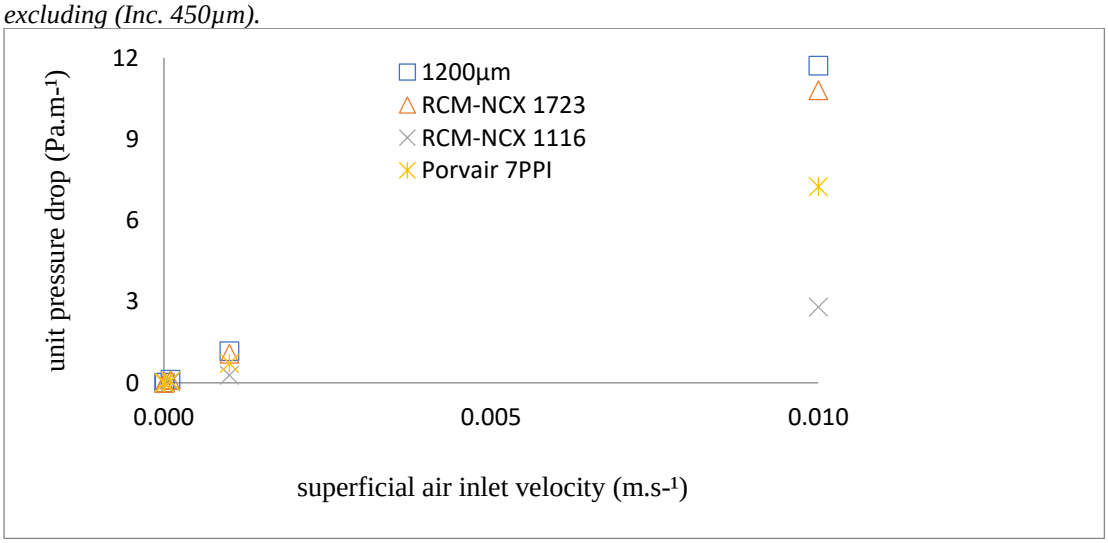

Fig.4. Plot of unit pressure drop (Pa) against superficial air inlet velocity (m/s) at Darcy regime of four structures excluding Inc. 450µm.

Table 1*: A tabular representation of the pore-structure and flow information of the high-density porous metallic structures.*						Darcy	Forchheimer-Turbulent	
Samples		Dp (mm)	Dw(mm)	ε (%)	L_G (mm)	$k_0/10^{-09}$ (m^2)	C (m^{-1})	C_F
Inconel 450µm	A	0.450	0.239	0.835	0.059	1.25	8541.55	0.342
Inconel 1200µm	B	1.230	0.489	0.906	0.176	15.56	1183.95	0.178
RCM-NCX 1723	D	1.855	0.691	0.809	0.254	16.89	1628.87	0.245
RCM-NCX 1116	C	2.454	1.286	0.898	0.341	65.36	594.66	0.181
Porvair 7PPI	E	1.466	0.858	0.897	0.405	25.14	1105.67	0.227

Where Dp is the pore sizes, Dw is the pore connectivity, ε is the pore volume fraction, $L_G$is the ligament thickness, k_0 is the permeability of the porous materials, C is the Form drag coefficient and C_F is the Forchheimer coefficient.

Fig. 5 presents the validation of modelling accuracy of Inc. 1200µm between CFD modelling and simulation (current work) and experimental measurement data of Otaru (2018) on unit pressure drop against superficial air inlet velocity. Comparing the CFD modelling to experimental measurement data shows a good validation agreement which has less than 5% error.

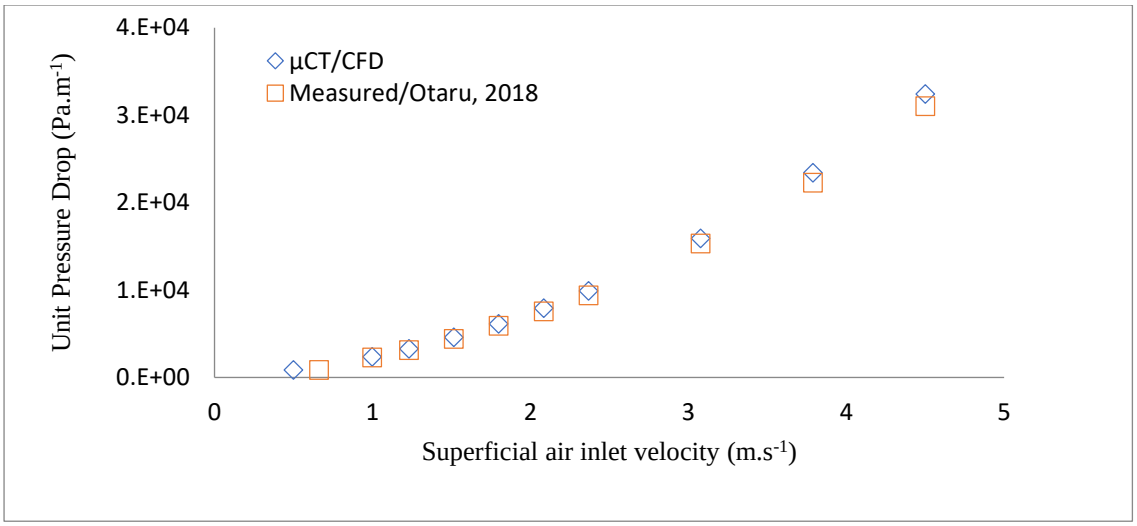

Fig.5. Validation plot of Inc. 1200µm (µCT/CFD current and Experimental /Otaru Ph.D. work 2018) unit pressure drop against superficial air inlet velocity.

CONCLUSIONS

Computational Fluid Dynamics CFD investigation of pressure drop across highly porous metallic structure has been resolved via tomography datasets for superficial velocity ranging from (0 – 6m.s^{-1}). This work provides an insight understanding into the determination of pressure drop and the flow information of the porous samples from Darcy – Turbulent flow regime. The effects of the variation of geometrical parameters like porosity and pore size were investigated. It was shown that a pore size reduction determines an increase of the pressure drop/gradient across the sample.

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Delineation of Solid Mineral Structures within Upper Part of Nasarawa State from Aeromagnetic Data

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Abstract

Aeromagnetic data was analysed and used to delineate the structural features of the upper part of Nasarawa state of Nigeria which consist of Kuje, Keffi and Akwanga. These structural features include: lineaments, faults and folds which are channels for the formation of solid minerals. In delineating these structural features, some enhancement techniques such as first vertical derivative, analytical signal and generalized derivatives were employed. The total magnetic intensity (TMI) map showed regions of different magnetic susceptibility which correspond to different lithology and depth of source rock. The TMI values ranges from -25.0 to 110.7 nT. The high magnetic signature occupied mostly the north-eastern and south- western part of the map corresponding to Akwanga and Kuje area respectively. The south-eastern part of the map which is the sedimentary region has low magnetic intensity. The analysis of the first vertical derivative map revealed fault zones, lineaments and intrusions. The trend of the lineament is in the NE-SW direction while that of the fault is in the E-W and NE-SW direction. The analytical signal showed amplitude range of 430.241-15738.841 nT/m. Most of the lineaments, faults and intrusions observed in the map has high analytical signal. On the other hand, the sedimentary region has low analytical signal. The generalized derivative map revealed a distinct demarcation between the sedimentary rock and the basement complex rocks. Also, some intrusions were observed in the generalized derivative map.

Keywords*: Basement complex rocks, lineaments, faults, intrusion.*

1.0 INTRODUCTION

The magnetic geophysical survey method has been useful in investigating subsurface geological structures. They have also been useful in giving information about the basement rocks, geologic structures like fractures, faults and contacts which may have influenced the occurrence of mineralized rocks. This method has been extensively used to delineate subsurface structures and provide an estimate of the thickness of non- magnetic sediments overlying magnetic rock (Ahmed et al.,.2012) . However, the interpretation of magnetic data can be ambiguous due to the dipolar nature of the magnetic field and the direction of magnetization in rocks. Despite these complications, magnetic surveys and their interpretations can give very useful geological information when applied to the right types of problems (Ahmed *et al*, 2012). Magnetic variation or susceptibility may be analysed using either total intensity or residual maps. Detailed geologic features such as the geometry and configuration of individual basement blocks can be shown by magnetic residual maps. They bring out the subtle magnetic anomalies that result from the changes in rock type across basement block boundaries. On the other hand, Total Magnetic intensity maps show large scale geologic features such as basin shape or anomalous rock types within the basement (Nettleton, 1962).
Aeromagnetic survey is one of the geophysical survey techniques carried out using a magnetometer attached to an aircraft and flown within the survey area. This enables quick coverage of much larger areas of the earth's surface . The resulting magnetic maps shows the spatial distribution and relative abundance of magnetic minerals (Most commonly magnetite) in the upper levels of the crust. The magnetic map shows the geology and the geological structures of the upper crust of the earth. This is very helpful where bedrock is hidden by thick sediments. The aeromagnetic method is very useful in mineral exploration as it helps to

delineate structures like faults, folds, contacts, shear zones and intrusions which are favourable areas for mineral deposits. These structures play important roles in the localization of minerals. These solid minerals can serve as an alternative source of income for the government.

The dwindling and fluctuating price of crude oil is biting hard on the Nigeria economy. Therefore, there is a great need to diversify and explore the solid mineral sector which can help boost the Gross Domestic Product (GDP) of the country. Furthermore, there is indiscriminate mining by local miners resulting to environmental degradation .This is because they do not know the particular location of the solid mineral veins .The outcome of this research work will produce database information that will attract investors in the solid minerals sector of Nigeria thereby reducing her overdependence on crude oil. This will contribute to the Country's Gross Domestic Product (GDP) and also create employment for the teeming unemployed youths. The problem this work tries to solve is to use the aeromagnetic data to interpret possible geology structures (fractures, faults, folds and shear zones) that could be possible host of gold deposits

2.0 LOCATION OF STUDY AREA

The study areas are located in upper part of Nasarawa State, and Kuje in Federal Capital Territory, Abuja, North- Central Nigeria and are bounded by Longitude 7.0^{o}E – 8.30^{o}E and Latitude 8.30^{o}N-9.0^{o}N with an estimated area of 60 x 160 km. Nasarawa State is accessed by road through Kaduna and Plateau States to the North-East, Taraba state to the South-East, Benue State to the South , Kogi State to the west and Abuja to the North-West. The State is blessed with abundant mineral resources and for this reason it is tagged, ''The Home of Solid Minerals in Nigeria". The study area extracted from the political map of Nigeria is shown in figure 1 below.

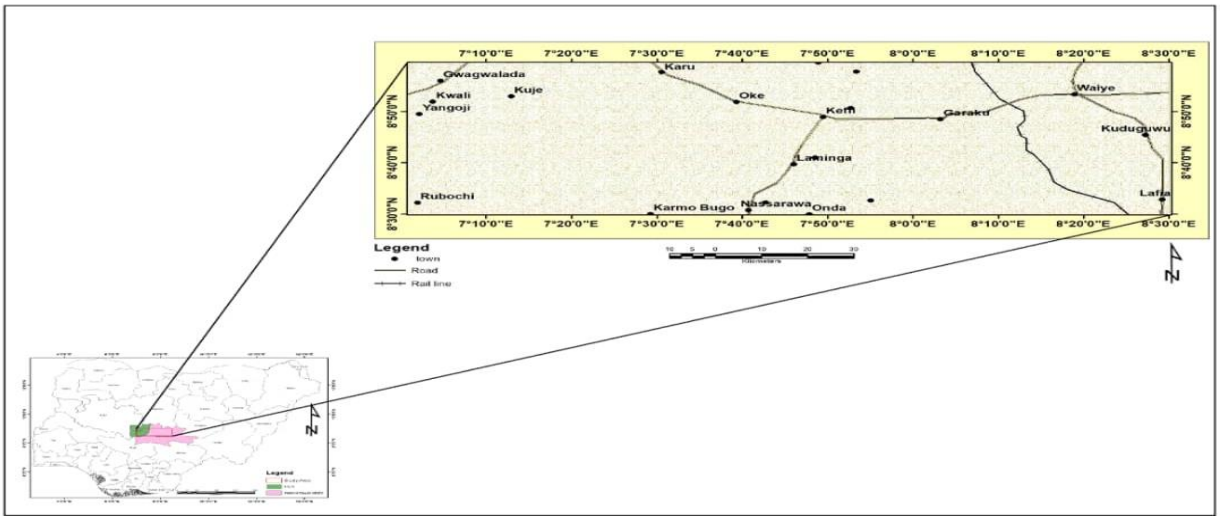

Figure 1: Location map of the study area

2.1 Review of Geology of the Study Area

The area of study is located within the middle Benue Trough which is the middle portion of the Nigerian Benue Trough. The Benue Trough itself is a rift basin in Central West Africa that extends NNE–SSW for about 800 km in length and 150 km in width. The trough contains up to 6000 m of Cretaceous Tertiary Sediment of which those pre-dating the mid-Santonian compressionally deformed (Benkhelil et al, 1989). The study area is covered with 60%

Basement complex rocks while the remaining 40% is made up of sedimentary rocks of the Benue Trough. There is an intrusion of the younger granites at the basement complex located at Mada and Afu . These younger granites therefore do not occupy any separate landmass of their own on the Basement complex. The Migmatite-Gneiss intricately associated with the older Granite occupy the areas of Karu, Gurku, Panda, Gitata to the Northwest, Keffi, Garaku Akwanga and Nasarawa Eggon to the north-central and Wamba, and environs to the northeast (Obaje, 2009). Sedimentary rocks of Cretaceous-Tertiary ages cover greater part of Nasarawa State in the South beginning from areas around Lafia, Doma through Obi, Jangwa, Awe and Keana. Eggon and Kokona; Salt deposits in Ribi, Keana and Awe; Limestone deposits at Adudu, and Jangwa; at Keffi, Akwanga, NasarawaEggon, TuduUku, etc. (Obaje, 2007). The geology map of the study area is shown in figure 2 below.

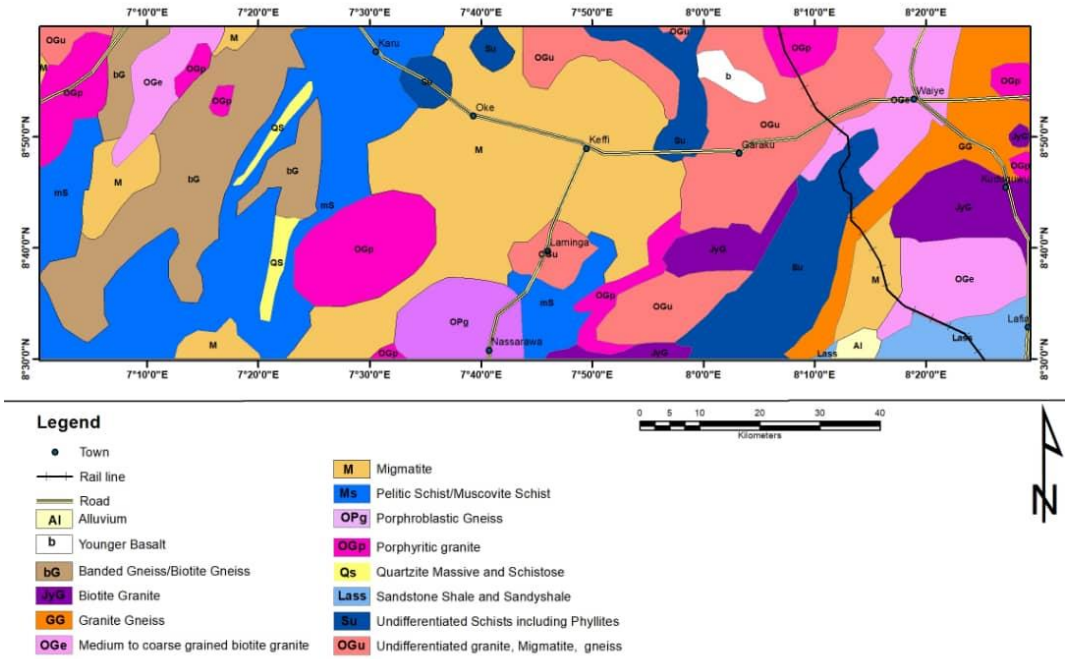

Figure 2: Geology map of the study area.

3.0 MATERIALS AND METHODS

The materials that were used for this project include:

a. Aeromagnetic data covering the study area
b. Radiometric data (Potassium, Thorium and Uranium)
c. Geology map
d. Geosoft (Oasis Montaj)
e. Microsoft Excel
f. Computer
g. Stationeries

Below are the procedures that were used in this research work:

1. Production of aeromagnetic map of the study area.
2. Application of reduction to equator and pole to remove the dependence of the data on angle of inclination and declination

3. Computing the first vertical derivative.
4. Evaluating the analytical signal so as to determine the exact location of the causative body.
5. Correlating the structures from 1VD and Geology Map.

3.1 Source of Data

The data for this research work were acquired from the Nigerian Geological Survey Agency (NGSA). The largest airborne geophysical survey was carried out in Nigeria in two phases between 2005 and 2010. The survey was partly financed by the Federal Government of Nigeria and the World Bank which was a part of a major project known as the Sustainable management of mineral resources Project. Every aspect of this geophysical work which includes; data acquisition, processing and compilation was carried out by Fugro Airborne surveys. The survey acquired both magnetic and radiometric data. The survey has a tie-line spacing of 500m, flight line spacing of 2 km and terrain clearance of 80km using TEMPEST system. This survey is intensive and more detailed for the objective of this research. The data covers the total number of sheets required for this work.

3.2 Theory of Methods

The theories backing the various filtering process applied to this research work include:

- **Vertical derivative**

The vertical derivative is commonly applied to total magnetic field data to enhance the most shallow geological source and can be calculated either in space or frequency domain. The enhancement sharpens anomalies over bodies and tends to reduce anomaly complexity, allowing a clearer imaging of a causing structure. Then transformation can be noisy since it will amplify short wavelength noise. First vertical derivative data have become almost a basic necessity in magnetic interpretation projects. The second vertical derivatives has more resolving power than the first vertical derivatives (Milligan and Gunn, 1997).

$L(r) = rn`$ 3.1

Where n = order of differentiation.

- **Analytic signal**

This is a filter applied to magnetic data and is aimed at simplifying the fact that magnetic bodies usually have a positive and negative peak associated with it, which in many cases make it difficult to determine the exact location of the causative body. Nabighian, (1972) has shown that for two-dimensional bodies, a bell shaped symmetrical function can be derived which maximise exactly over the top of the magnetic contact. The three dimensional case was derived in 1984 also by Nabighian, 1984. This function is the amplitude of the analytical signal. The only assumptions made are uniform magnetization and that the cross section of all causative bodies can be represented by polygons of finite or infinite depth extent. This function and its derivatives are therefore independent of strike, dip, magnetic declination, inclination and remanent magnetism (Debeglia and Corpel, 1997).The 3-D analytical signal, A, of a potential field anomaly can be defined (Nabighian, 1984) as:

$$A(x,y) = \left(\frac{\partial M}{\partial x}\right)x + \left(\frac{\partial M}{\partial y}\right)\hat{y} + \left(\frac{\partial M}{\partial z}\right)\hat{z} \quad 3.2$$

Where M is the magnetic field

The analytical signal amplitude can now be calculated (Debeglia &Corpel, 1997) as:

$$|\,A(x,y)| = \sqrt{\left(\frac{\partial M}{\partial x}\right)\hat{x}^2 + \left(\frac{\partial M}{\partial y}\right)\hat{y}^2 + \left(\frac{\partial M}{\partial z}\right)\hat{z}^2} \qquad 3.3$$

- **Generalized Derivative (GD)**

The generalized derivative operator is an enhancement tool used to process potential field data. It produces an amplitude balanced image of the derivative of a potential field in any direction in three-dimensional space. Cooper and Cowan (2011) introduced generalized derivative operator, which uses analytical signal amplitude to balance a combination of horizontal and vertical derivatives of the data. It mainly enhances regions of geological contact.

4.0 RESULTS AND INTERPRETATION

4.1 Total magnetic intensity

The total magnetic intensity map (in figure 3) produced shows areas of varying colours which connotes regions with rocks of different magnetic susceptibilities and also corresponding to different lithology and depth of source rock. The map exhibits both positive and negative magnetic anomalies ranging from -25.0 to 110.7 nT . The areas with pink and red colour depict rocks with positive anomalies while green to blue depicts negative anomalies. Changes in magnetic signature from high to low and vice versa were observed in the map. The high magnetic signature occupies mostly the North-eastern and South-western region of the map while the South-eastern and North-western region have low magnetic signatures.

The amplitude of a magnetic anomaly depends on the magnetic susceptibility of the rocks at specific geographical locations. The south-eastern part of the map with low magnetic signatures depicts the sedimentary rock region which corresponds with the Lafia sandstone as well as the alluvial deposits. This tallies with what was obtained from the geology map of the area. The low magnetic signature at the south-eastern part of the map may be attributed to low magnetic minerals in the sedimentary rock.

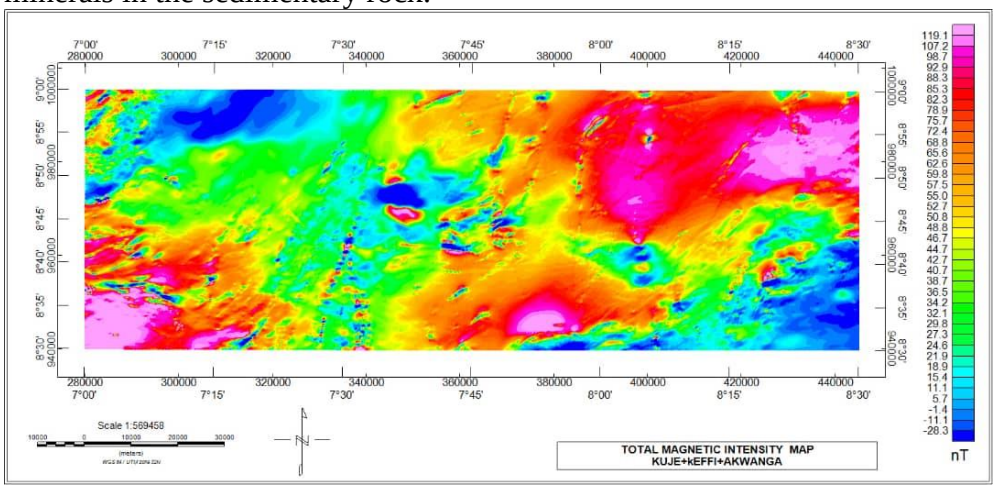

Figure 3:Total magnetic intensity map of the study area

4.2 TMI Reduced to Equator (RTE)

The TMI data was reduced to equator by assuming an inclination (I) equal to -7.25 and a declination (D) of -1.97 according to IGRF (International Geomagnetic Reference Field) .The

RTE map (in figure 4) helps to remove the effect of magnetic inclination in regions with low latitude by centring the peaks of magnetic anomalies over their sources.
The RTE and the TMI map of the study area look similar. The extreme south-eastern region of the map has low magnetic frequency which is an indication that it is a sedimentary region. This tallies with what was seen on the geology map of the area. The north-central area which shows greenish colouration has a relative weak magnetic signature which extends towards the north-western area. The negative magnetic anomaly is as a result of weathered basement.

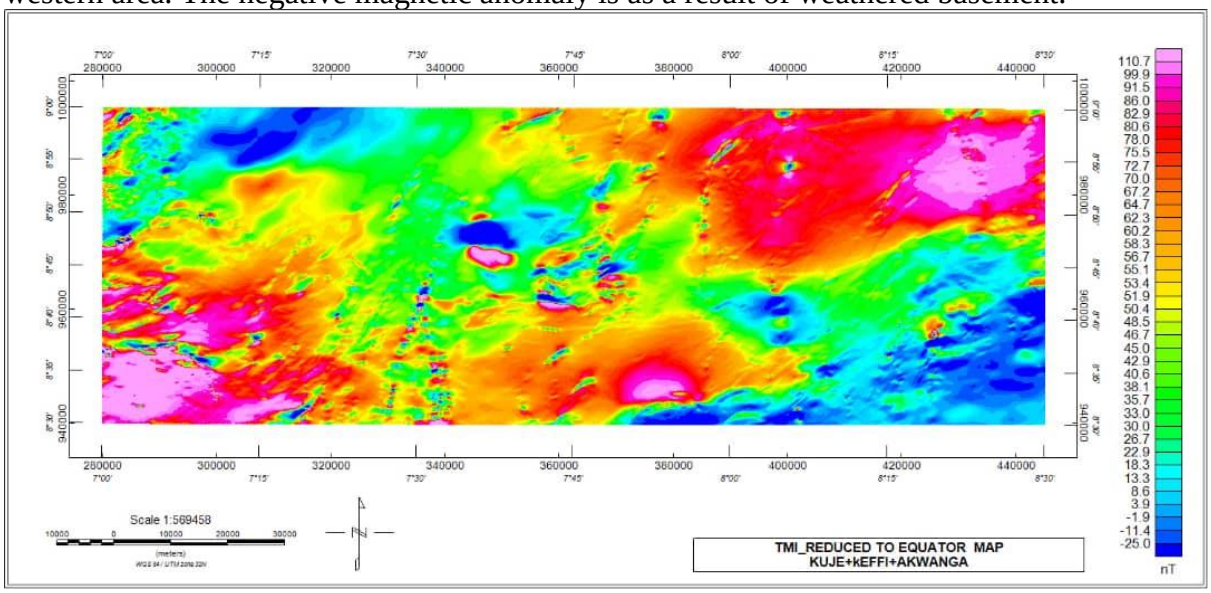

Figure 4: The reduced to equator map of the study area.

4.3 First Vertical Derivative Map (FVD)

The first vertical derivatives enhances near surface features such as faults, folds and lineaments . The vertical derivative map is much more responsive to local influence than to broad or regional effects and therefore tends to give sharper picture than the Total Magnetic Intensity map. One of the important applications of first vertical derivatives is finding magnetic lineaments and determining the boundary between lithological units more precisely.
In the coloured FVD map shown in figure 5 , pockets of intrusions were seen around the central and south-eastern portion of the map. The major intrusions were labelled A1, A2, A3 and A4. The portion A1 corresponds to the porphyritic granite; A2 undifferentiated granite-migmatite-gneiss while A3 and A4 are biotite granite intrusions. Also a clear demarcation was observed between the sedimentary rock and the basement at the extreme south-eastern end of the map. Series of lineaments were seen on the FVD map. The trend of the lineaments and other structural features observed were discussed extensively in the FVD grey scale map.

4.4 First Vertical Derivative (Grey Scale Map)

The structural features in the FVD are clearer in the grey scale map (figure 6). Fault lines were seen in the western and eastern end of the map. Many lineaments were seen but the prominent ones were mapped. Worthy of note is a long stretch of lineament towards the south-west region located at latitude 7.30^0N. An intrusion of Porphyroblastic gneiss was observed close to this lineament. Another prominent lineament was mapped towards the north-eastern area of the map which terminated at a thin patch of an intrusive rock corresponding to the medium to

coarse grained biotite-granite .These lineaments trend in the northeast-southwest direction while the fault lines trend mostly NE-SW and E-W directions.

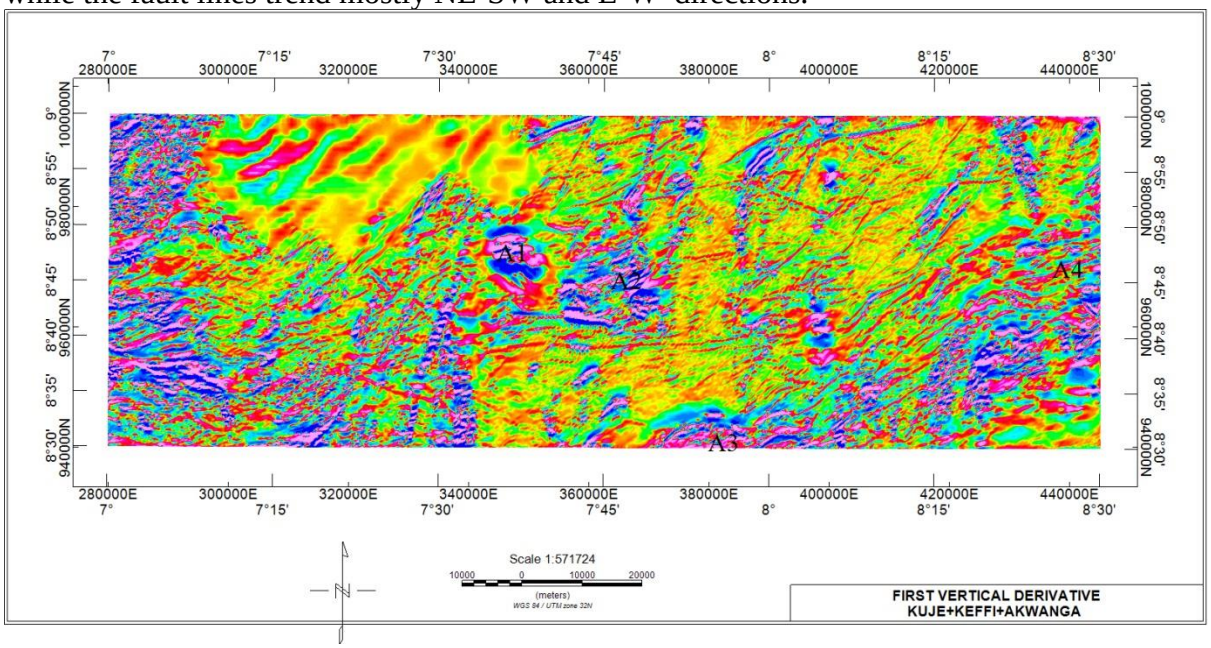

Figure 5: First Vertical Derivative map (Coloured)

Also clearly seen in the map are folds. These folds were clearly mapped out and one of the folds was seen to occur at the contact between the sedimentary rock and the basement. The other folds were found in the areas of intrusion, denoted as A3 and A4.These folds in A3 and A4 were as a result of intrusions of magma in the rock, forcing the overlying rock to arch up. Finally, towards the north-western region of the map marked in black curve in the grey map and which lies between longitudes 7.10^0-7.37^0 is an interpolated data .There was no interpretation on the data because it did not give the true picture of the geology of the area.

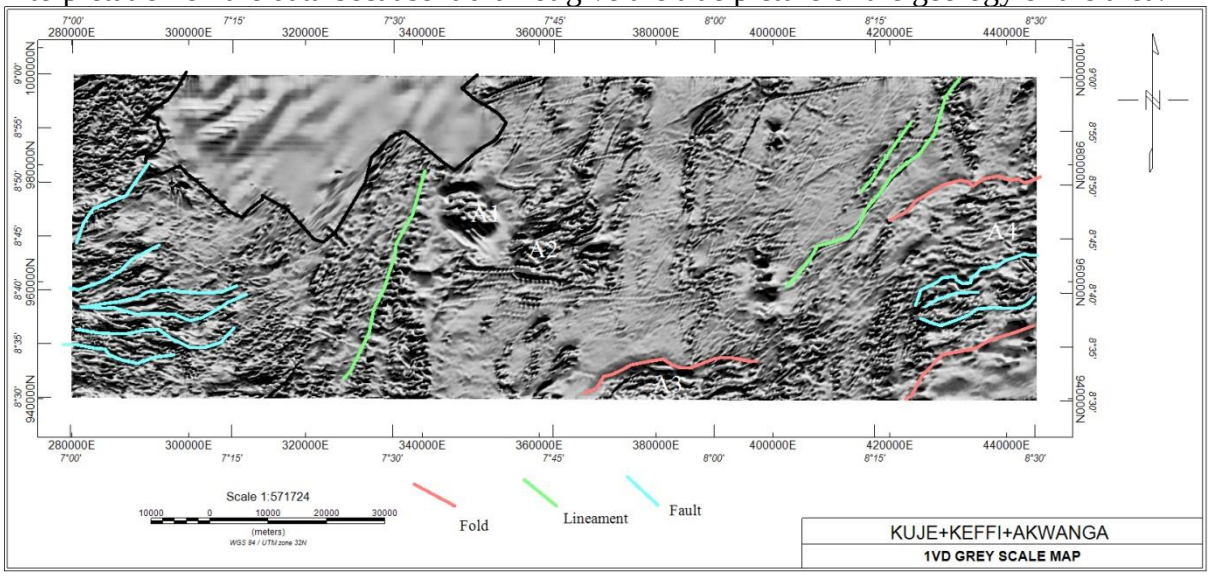

Figure 6: First Vertical Derivative map (grey scale)

4.5 Analytical Signal (AS)

The analytical signal filter represents the magnetic anomaly of the causative body which depends on the location of the body (horizontal coordinate and depth) and devoid of its magnetization direction.

From the 3-D analytical signal map shown in figure 7, the amplitude range of 430.241 - 15738.841 nT/m was observed. High amplitude analytical signal values observed can be attributed to the presence of magnetic minerals present in the rock. It was observed that the intrusive have high analytical signals. Also the elongated lineament which is located at longitude 7.30^0E has high analytical signal which is an indication that it is laden with magnetic minerals. The faulted region located at the western edge of the map has high presence of magnetic minerals.

Conversely, it can be observed that the sedimentary region at the extreme south-eastern end of the map has low analytic signal with some few patches of intrusions which has high analytical signal. The low analytic signal is as a result of low magnetic minerals in the sedimentary region which may have been leached or depleted weathering and deposition process. Some tiny spots with high analytical signal were seen in the sedimentary region, which suggests that little intrusion occurred in the sedimentary region. The intrusive A1, A2, A3 and A4 indicated in the FVD map have high analytical signal. Moreover, other pockets of intrusive show that they contain ferrous minerals.

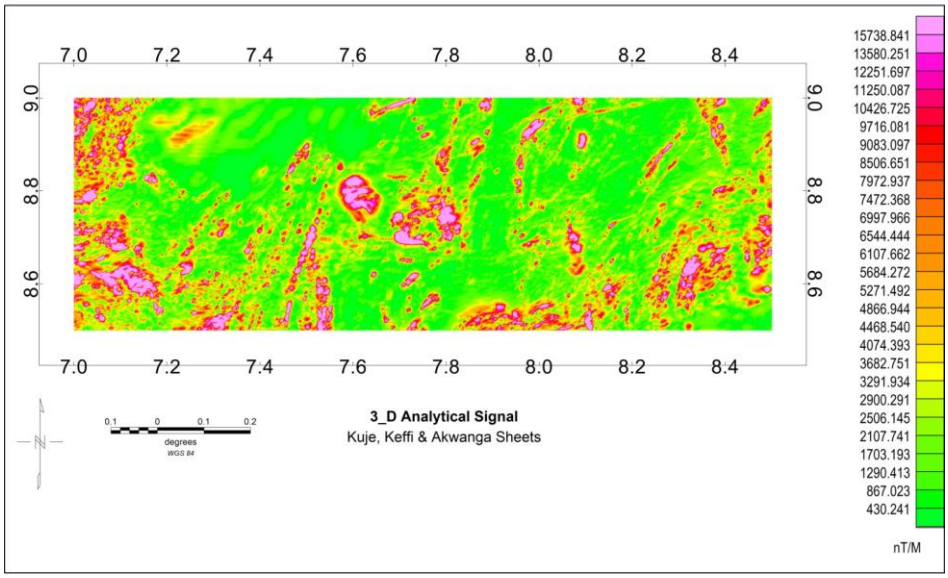

Figure 7: Analytical signal map

4.6 Generalized Derivative (GD)

The generalized derivative operator is an enhancement tool used to process potential field data. It produces an amplitude balanced image of the derivative of a potential field in any direction in three-dimensional space. Cooper and Cowan (2011) introduced generalized derivative

operator, which uses analytical signal amplitude to balance a combination of horizontal and vertical derivatives of the data. It mainly enhances regions of geological contacts.

From the general derivative map in figure 8, some intrusions were seen. One of the intrusions is located at longitude 8.10^0 and it corresponds with the biotite-granite rock in the geology map. This intrusion is not clearly shown in the First Vertical derivative map though it appeared as a depression in the grey scale map. Another intrusion was seen at longitude 7.35^0E and the rock corresponds to the porphyritic granite. Furthermore, a distinct contact was seen between the sedimentary rock at the extreme south-eastern end and the basement based on distortion of magnetic signatures.

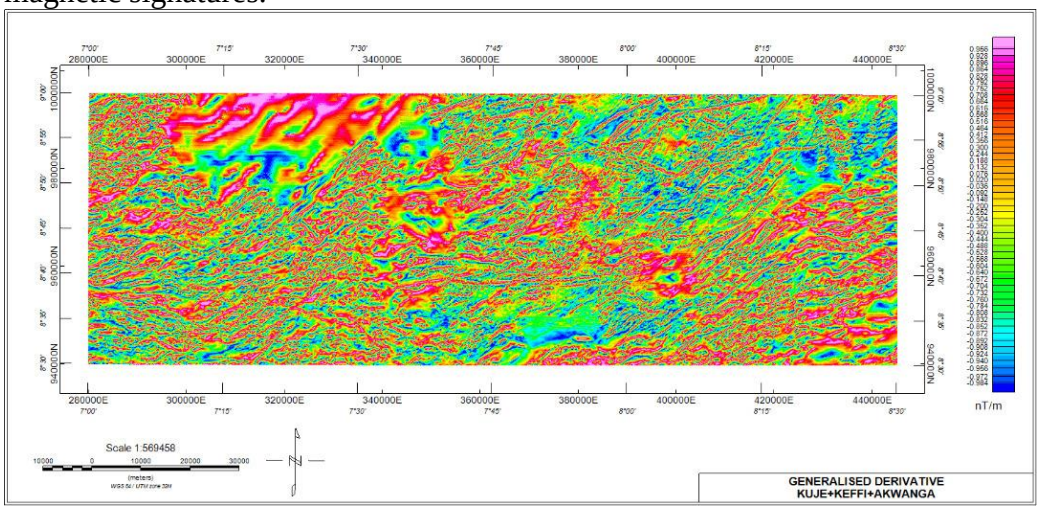

Figure 8: Generalized derivative map of the study area

5.0 DISCUSSION OF RESULTS

The TMI map showed areas with high and low magnetic susceptibility that corresponds with the geology of the study area. The first vertical derivatives revealed intrusions, faults , folds and lineaments. The lineament trend is in the NE-SW direction. The analytical signal showed high amplitude response in the fault zones, lineament and intrusions, indicating the presence of ferrous minerals. The generalized derivative revealed a clear geological contact between the sedimentary rock located at the extreme south eastern region and the Basement complex rocks.

5.1 Conclusion

The analysis of the aeromagnetic data of the upper part of Nasarawa state revealed many structural features.The fault zones and lineaments seen are possible channels for mineralization.

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Evaluation of Passenger Perception of Public Transport Hubs in Abuja-Nigeria

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Abstract:

Transportation plays an important role in the economic systems of most developed countries of the world. The public transport system in Abuja, FCT which caters for about 1.4 million commuters is confronted with many complicated and heterogeneous problems. This study therefore is aimed at evaluating passenger satisfaction with the service quality attributes of public transport hubs in Abuja, Nigeria. The study was conducted using a "Mixed-Method" technique that involved qualitative and quantitative data collection methods. A survey was carried out and Five (5) samples of transport hubs were selected for this study which includes; Nyanya-Karu-Mararaba axis, Kubwa-Zuba-Suleja axis, Lugbe-Kuje-Gwagwalada axis, Dutse-Bwari axis, and the City Centre axis. A random selection of 400 public transport hub users was made to draw out the overall users' perception with the use of public transport hubs in Abuja, using a self-administered questionnaire. The data collected was analysed using descriptive statistics and findings were presented in form of tables and charts, illustrating passengers' perceptions on the quality attributes and seivices provided in Abuja transport facilities. Out of 14 variables analysed, 12 quality attributes services of public transport hubs in Abuja were highly unsatisfactorily recorded by the respondents. Only 2 variables (Good security measures within and around terminal and Traffic management in and around the terminal) partially met the expectations of passengers. The study therefore showed that the passengers of public transport hubs were not satisfied with the quality attribute and services provided by Abuja transport facilities.

Keywords: *Abuja, Transport Hub, User Perception, User Satisfaction.*

INTRODUCTION

Transport sector serves as a vital component of cities in developed and developing countries of the world (Rodrigue, 2017). In recent years, multimodal transport system (MMTS) has been given utmost priority globally (Cherchenko, 2018). MMTS are developed to explore and harmonize several transportation modes for the safety and comfort of commuters (Izuwah, 2018).

It is clear that most cities of developing countries are experiencing many problems and challenges in their transport sector, which are attributed to congestion, pollution, lack of passenger comfort and user safety requirements, poor accessibility, and decline in public patronage (Pojani and Stead, 2015). The use of public transport in most of cities has not been adopted because the current public transport facilities are largely operated by informal operators that are mostly unregulated. Furthermore, there is a view of public transport as a means of transportation for only the poor, as users' resort to this means because they have no other available and realistic option (Cervero and Dai, 2014).

The Federal Capital Territory Abuja public transport system caters for about 1.4 million commuters (Oniyangi, 2012) and challenged with a myriad of problems such as dilapidated facilities and inadequate service of the public transport operator resulting in avoidable delays and traffic congestions.

Inadequacy of these transport facilities in developing cities has led people to adopt private vehicles, thereby resulting in traffic gridlocks, congestion and environmental pollution (Breuil and Enskat, 2017).

The development of the public transport sector in developing countries is impeded by many factors including; dilapidated infrastructure, long travel distance and other risks (Pojani and Stead 2015). This has created a bad perception on the public transport system (Cervero and Dai, 2004). Furthermore, the unregulated growth in cities poses a challenge to planners (Brown and Chikagbum, 2018) and to address this, investments in realistic and sustainable options are essential in achieving an economically efficient, environmentally friendly, socially inclusive, and a robust transportation system (Muhammad and Peter, 2016).

According to Yakubu (2006) The Abuja Metropolitan Management Council (AMMC) considered the current transportation structure to be completely unbefitting and insufficient for the status of a capital city, the council consequently, highlighted the need to re-organize the sector as envisioned in the Abuja master plan. This includes introduction of high capacity types of transport services such as metro rail lines and Bus Rapid Transport (BRT) for intra and inter-city movement and improved terminals.

THE CONCEPTS OF USER SATISFACTION AND PERCEPTION ON QUALITY OF FACILITIES AND SERVICE PROVIDED

Oliver (1997) described satisfaction as contentment of duty to customer. Budiono (2009) described it as a perception that a product or system feature or the system or product itself provides a delightful level of consumption-related fulfillment, including levels of over-fulfilment or under-fulfillment as the case may be. The term 'satisfaction' is also recognized as "contentment of desire, claim, and need." Users' desire contentment is a relative process that give rise to contentment responses. Payne and Holt (2001), stated that, the prevailing theoretical model engage in research into users'/customers perception is the expectancy/disconfirmation model where users'/customers are convinced (dissatisfied) if their experience for the service perceived outstrip their anticipation for the service. He further explained that customers'/users' satisfaction is analyzed within this framework by conducting an examination on service good worth and the attributes of the service good worth that rises the cognizant and vision. Gronroos (1984) also defined service quality as a relationship between perception of service and customers' anticipation.

Budiono (2009) described service quality in five distinct perspectives;

i. Tangibles: Manifestation of Personnel, Checkup Facilities and Expeditions.
ii. Reliability: Capability to carry out the Services promised reliably and precisely.
iii. Responsiveness: Cheerful compliance in assisting users' and generate quick service.
iv. Assurance: Enlightenment and politeness of workers and their capability to infuse belief
v. Empathy: The individualized courtesy a firm offers to the users' (Care).

He further described quality as the key perspective that is factored into users' perception or opinion. Diverse studies and review of papers concerning fulfillment of users' need on public transport hubs were carried out to develop a desirable public transport hub. It was discovered that, elevated frequency of reliable services, and fares that place value for money as important needs of UK public transport users'/passengers, (Department for Transport, 2003).

METHODOLOGY

The research employed a mixed approach and was descriptive in nature. According to Williams (2007), descriptive research method studies a situation in its existing state, and it includes identification of characteristics of a specific phenomenon, or the exploration of correlation between two or more phenomena. Quantitative method were employed in form of survey

questionnaires seeking demographic information on gender of passengers, satisfaction level with functionality, spaces, services and environment around transport hubs.

The research targeted the possible riders/commuters of age group between 15 and 60 years who have chosen public transport as their mode of transportation. The sample size used for the survey was as established by (Yamane, 1967) using the formula:

SPSS and MS Excel tools were used to process he data collected with the questionnaire from the respondent. Percentages, tables and cross tabulation were used to analyze quantitative data. A 5-point Likert scale (1-Strongly disagree, 2-Disagree, 3-Undecided, 4-Agree and 5-Strongly agree) as adopted to allow individual expression on how much they agree or disagree with a statement, and was used to rank data numerically for ease of analysis (Willits et al. 2016).

Instruments of Data Collection

Data was obtained from the respondents with the use of structured closed-ended questionnaires. The questionnaire were designed to seek information from the possible passengers of public transport hubs in Abuja, who for the purpose of this research are considered as the users. The questionnaire sought responses on issues relating to the reasons for patronage of public transport and the reason for non-patronage.

Using the variables that were established from literature reviews, questions were structured to respond to research problem. The research employed a 5-Likert scale (1-Strongly disagree, 2-Disagree, 3-Undecided, 4-Agree and 5-Strongly agree) response questions in the questionnaires.

Table 2: Respondents Distribution

Bus Terminals	Transit Dependent Rider	Choice Dependent Rider	Total Number of Respondents	Percentage of Respondents
Nyanya,Karu and Mararaba Axis	55	25	80	20%
Kubwa, Zuba and Suleja Axis	47	33	80	20%
Lugbe, Kuje and Suleja Axis	50	30	80	20%
Dutse and Bwari Axis	43	37	80	20%
City Centre Axis	58	22	80	20%

Table 3: Age Distribution of the Respondents

Age Group (yearly)	**Number of Respondents**	**Percentage of Respondents**
15-24	79	19.75%
25-34	117	29.25%
35-44	109	27.25%
45-54	57	14.25%
55- Over	38	9.5%
	400	100%

Table 4: Respondents Distribution base on Employment Status

Employment Status	**Number of Respondents**	**Percentage of Respondents**
Government Sector	101	25.25%
Private organized	85	21.25%
Self-employed	59	14.75%
Unemployed	96	24%
Pensioner	24	6%
Student	35	8.75%
	400	100%

Table 5: Variables of the Study

Variable Code	Variables of the Study
P1	Terminals are available and accessible
P2	Terminals are adequate in terms of space
P3	Good health and safety measures within terminals
P4	Good Security measures within and around terminals
P5	Restrooms and Conveniences are available at terminals
P6	Standard Retail shops and Restaurants available at terminals
P7	Short waiting time at terminals
P8	Terminals are well maintained
P9	Availability of users' complaints and feedback system
P10	Adequate number of ticketing stalls
P11	Adequate parking space
P12	Traffic management in and around the terminal
P13	There is need for more transport terminals
P14	Satisfied with overall Services and Condition of public transport facilities

RESULT AND DISCUSSION

Figure 2 and Table 6, below shows the statistical frequency distribution of respondents' feedback of the general desire and factors that influence the individual quality attributes of facilities and services for their satisfaction with the present public land transport terminal building in Abuja, (Table 6 and Figure 2). The table shows that the quality attributes of facilities and services of public land transport terminal buildings that influence users' comfort were also pitiably perceived. Take for example; variable P8 (Terminals were well Maintain), having a mean score of 1.99 (<5.0), obtained 32% percent 'Strongly Disagree', 48.5% percent 'Disagree', 8.5% percent were 'Undecided' and 11% percent goes under 'Agreed', none of the respondents were strongly satisfied with the existing transport terminal buildings in Abuja. Therefore, the study revealed that, more than 80% percent of the respondents are dissatisfied with the maintenance services of the Terminal buildings, which is in line with the findings of Straddling et al. (2007) and Andaleeb et al. (2007) that comfort has the greatest impact on users satisfaction. Similarly, 80% respondents recorded that transport terminal buildings in Abuja were ill maintained, 8.5% of the respondents were marked Undecided, and close to 82% of the respondents marked for the need of more transport terminal buildings in Abuja. Therefore, 3-variables, P1 (Terminals are available and accessible), P8 (Terminals are well maintained), and P13 (There is need for more transport terminal building), had a mean score of 2.42, 1.99, and 4.06, respectively. However, only 2-variables partially met the expectation of passengers in Abuja. The first variable is P7 (Short waiting time at terminals), with a mean score of 2.33, while the second variable is P12 (Traffic management in and around the terminal), with a mean score of 2.6. This finding can be supported by that of (Faulks, 1990) in the study of bus provision in developing world cities. However, none of the variables make the '5' point mean score, only variable P13 (There is need for more transport terminal building) has a high mean score of 4.06, in which more than 80% of the respondent were strongly agreed with the need for more transport terminal buildings.

The result of the study shows that out of 14 variables analyzed, 12 quality attributes services of public transport hubs in Abuja were strongly unsatisfactorily recorded by the respondents. 2-variables (P4 and P12) partially met the passengers' anticipation; however, even for the 2-variables pointed out above, more than 35% of the respondents were undecided.

Table 6: Absolute and Relative Frequency Distribution of Abuja Public Transport Hubs Satisfaction (Findings and Discussion).

Variable Code	Strongly Agreed		Agreed		Undecided		Disagree		Strongly Disagree		Mean
	#	%	#	%	#	%	#	%	#	%	
P1	8	2%	99	24.75	62	15.5%	125	31.25%	95	23.75%	2.42
P2	8	2%	41	10.25%	85	21.25%	181	45.25%	85	21.25%	2.27
P3	14	3.5%	37	9.25%	87	21.75%	169	42.25%	93	23.25%	2.28
P4	16	4%	55	13.75%	95	23.75%	174	43.5%	60	15%	2.48
P5	8	2%	28	7%	60	15%	180	45%	124	31%	2.04
P6	0	0	37	9.25%	64	16%	188	47%	111	27.75%	2.07
P7	20	5%	60	15%	50	12.5%	171	42.75%	99	24.75%	2.33
P8	0	0	44	11%	34	8.5%	194	48.5%	128	32%	1.99
P9	0	0	25	6.25%	65	16.25%	190	47.5%	120	30%	1.99
P10	8	2%	55	13.75%	95	23.75%	165	41.25%	77	19.25%	2.38
P11	16	4%	58	14.5%	69	17.25%	162	40.5%	95	23.75%	2.35
P12	18	4.5%	90	22.5%	77	19.25%	141	35.25%	74	18.5%	2.60
P13	128	32%	194	48.5%	54	13.5%	24	6%	0	0	4.07
P14	0	0	49	12.23%	44	11%	189	47.25%	118	29.5%	2.06

Note. # = Number of Respondents, % = Percentage of Respondent

Table 7: Level of Passengers' Satisfaction with Public Transport Services

Variable Code	Variables Description	Mean
P1	Terminals are available and accessible	2.42
P2	Terminals are adequate in terms of space	2.27
P3	Good health and safety measures within terminals	2.28
P4	Good Security measures within and around terminals	2.48
P5	Restrooms and Conveniences are available at terminals	2.04
P6	Standard Retail shops and Restaurants available at terminals	2.07
P7	Short waiting time at terminals	2.33
P8	Terminals are well maintained	1.99
P9	Availability of users' complaints and feedback system	1.99
P10	Adequate number of ticketing stalls	2.38
P11	Adequate parking space	2.35
P12	Traffic management in and around the terminal	2.60
P13	There is need for more transport terminals	4.06
P14	Satisfied with overall Services Condition of public transport facilities.	2.06

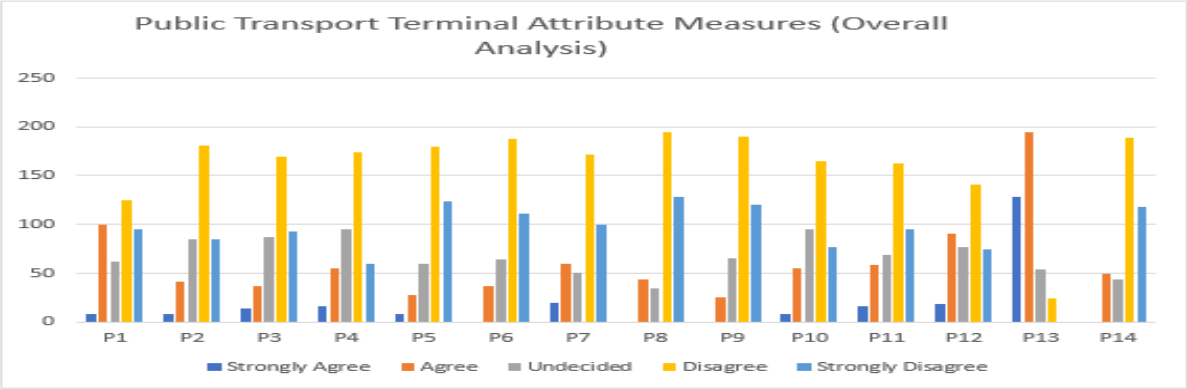

Figure 2: Bar-Chart Showing Public Transport Terminal Attribute Measures

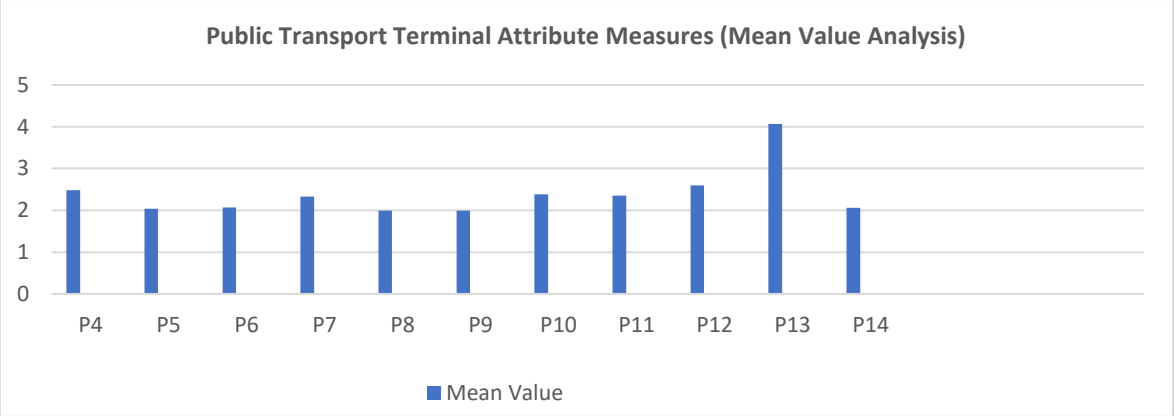

Figure 3: Bar-Chart Showing Public Transport Terminal Attribute Measures (Mean Value Analysis)

CONCLUSION AND RECOMMENDATION

In conclusion, the study therefore reveals that Abuja public land transport users were not satisfied with the quality attribute of facilities and services provided in the terminal buildings. Therefore, based on the findings of this study, the following recommendations were made.
Government should develop a strategic policy plan.
Collaboration between Federal Capital Territory Admiration (FCTA) and relevant stakeholders.
Terminal buildings should be developed in line the new concept of Transit Oriented Development (TOD).

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An Empirical Approach For Determination of Building Stability Using CORS Data

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Abstract:
The advent of continuously operating reference stations (CORS) in recent times has improved theapacity to obtain the needed data (continuous, reliable and homogenous) for studies on building deformation and earth plate motion. This paper investigates the stability of the building on which the CORS is located in Modibo Adama University of Technology Yola, with a view to monitoring the possibility and rate of deformation of the building upon which the CORS is located. A quantitative research approach has been adopted in this study wherein the station point positions for a 365day of the year (DOY) period was analyzed for the years 2011 and 2012 using the ordinary least squares (OLS) approach to determine station velocity (motion) and average positional error contribution in 3-D. Raw downloads of Station position and orbit files were post processed using the RTKLib software. The results obtained indicate an average velocity of ±0.00000023m/s and 0.0000002m/s for the years 2011 and 2012 respectively. This reveals a constant and insignificant motion of the FUTY CORS thereby indicating stability of the, building upon which the station is hosted. The insignificant motion attributed to some factors such as Eotvos and Earth's rotation therefore do not pose any sign of danger to either the, building upon which it is hosted and. It is recommended that similar analysis should be performed on all the CORS across the country topecify that such study might provide preliminary information about the stability of the Nigerian platform but it would not be sufficient to base the entire conclusion on CORS data alone.

Keywords: *CORS data, Monitoring, Deformation, Building Stability*.

INTRODUCTION

Building collapse is fast becoming an endemic situation that has traumatized our environment in recent times (Dabara, 2016). Asides the use of sub-standard building materials, the problem of building collapse has also been much attributed to movements and instabilities in the building **(**Kelsey, 2012**)**. These movements in the building are caused by several factors which include pressure imposed on building by human use, reaction of building materials to environmental factors as temperature, relative humidity, climate change and others. In an attempt to reduce the rate of collapse of buildings, building deformation monitoring is often embarked upon in order to determine the stability or otherwise of the building **(**Ibrahim et al, 2010**).** Over the years, the task of building deformation monitoring has been an exclusive duty of the geodesist. He performs this task with the use of various conventional surveying instruments wherein observations are taken repeatedly over some specified targets on the building. This practice had over the years yielded the required accuracy for collapse forecasting and quick relocation of possible victims **(**Nelson, 2016**)**. Howbeit, this method is labor intensive and probably error prone due to multiple observations and computations at different epochs.

However, the unique advantage of continuous and repetitive observational data offered by the use of Continuously Operating Reference Stations (CORS) eliminates this disadvantage of the use of conventional instruments for deformation monitoring data. The technological advancement of GNSS receivers and the addition of more satellite networks to the GNSS constellation, have allow greater measurement accuracy and smaller positional inconsistencies in the results obtainable from CORS. Consequently, the CORS has become a really accurate

and reliable tool for measuring building movements **(**Ji and Herring 2011**).** Past studies by Kutoglu (2010), Kaloop and Li (2009), Rutledge et al. (2001) and Chen et al. (2000) have demonstrated the applicability of GNSS positioning for deformation monitoring in Asia and Europe. The results from their studies have shown that the validity of repeated GNSS data and by extension CORS in providing engineers with information about structural safety design parameters and also to update building inspection routines. However, this approach has not been validated by any study around the equator.

Furthermore, there has been an increase in demand and reliance on GNSS products from a variety of users. The surveying industry is one of the larger and more discerning of these industries, with accuracy requirements perhaps rivaled only by specialized scientific monitoring operations. The technological advancement of receivers and the addition of more satellite networks have allow greater measurement accuracy and thus smaller inconsistencies in the results obtainable from CORS. Consequent upon these, the CORS is herein presented as a reliable tool for measuring station movements.

This study therefore uses the CORS located at Modibbo Adama University of Technology, Yola to determine the stability of the building upon which it is located. This study area located in Nigeria was chosen due to its closeness to the equator in order to examine the suitability of the use of GNSS for deformation monitoring / building stability within the study area. The aim of this research is to monitor the stability of the CORS located at Modibbo Adama University of Technology, Yola, Adamawa State.

STUDY AREA

The study area is Modibbo Adama University of Technology (MAUTECH), Yola is located in Girei Local Government Area of Adamawa state. It is situated in the North Eastern part of Nigeria with geographical coordinates of latitude 9^0 19’ 48” and 9^0 24’ 18”, longitude of 12^0 28’ 02” and 12^0 30’ 32” covering an area land mass of 36,917km^2. Yola town is the capital of Adamawa state. Plate 1 and figure 1 describe the position and location of the CORS used for this study.

Plate 1: The CORS located on the roof of the Faculty of Environmental Technology building at Moddibo Adama University, Yola.

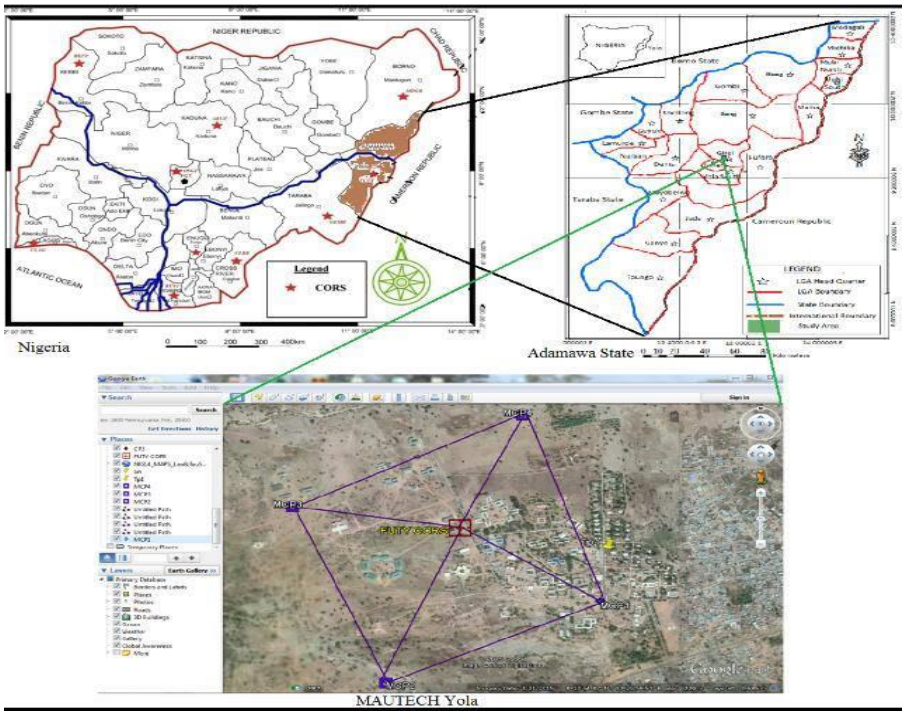

Figure 1: Location of the COR Station at Modibbo Adama University, Adamawa state

MATERIALS AND METHODS

Materials

The data acquisition for this work is basically positional information and coordinates from the FUTY COR station in Modibbo Adama University of Technology Yola Adamawa state. The information used as received from the COR station is as follows:

Station position information files: The RINEX files containing station position is downloaded from the NIGNET website. The observation file and orbit file for each day of the year for the years 2011 and 2012 were collected and processed accordingly.

Navigation and Clock error files: The final orbit solutions (recoverable after 15days of observation broadcast) were downloaded from www.igscb.jpl.nasa.gov/components/data.html link.

Tropospheric delay correction: Conventional Saastemoinen model was used for tropospheric delay estimation. Surface pressure and temperature used for implementation of the Saastemoinen model are obtained from Nigerian metrological Centre (NIMET) using the standard temperature and atmospheric pressure of Yola, Adamawa state.

Method

Determination of the stability of the building upon which the COR in Modibbo Adamawa university is located was achieved through the procedure illustrated by Figure 2.

The procedure utilized in the study is as sequentially described below:

Download Navigation files of NIGNET stations of daily observations over a 2-years period from NIGNET website.

Download FKP, VRS and MAC correction solutions from NIGNET website to correct for orbit, atmosphere and multipath.
Post Process items 1 and 2 in static mode using scientific software (RTKLib)
Analyze changes in position between the results obtained in 3 over time using Ordinary Least squares model to determine the movement of the station.

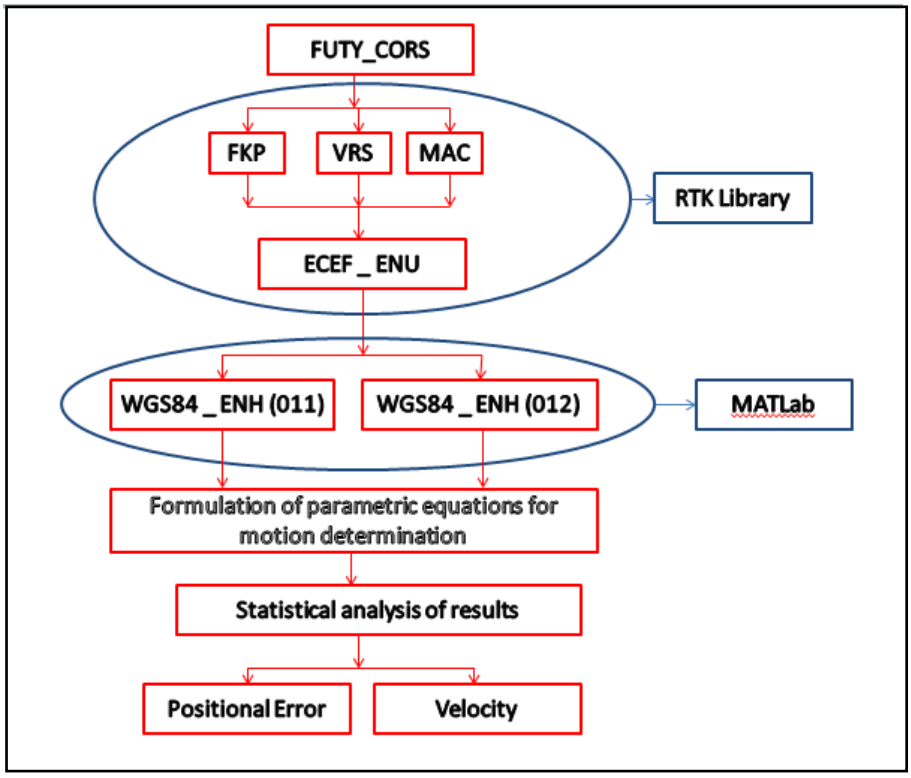

Figure 2: Flow diagram of research method

The procedure utilized in the study is as sequentially described below:
Download Navigation files of NIGNET stations of daily observations over a 2-years period from NIGNET website.
Download FKP, VRS and MAC correction solutions from NIGNET website to correct for orbit, atmosphere and multipath.
Post Process items 1 and 2 in static mode using scientific software (RTKLib)
Analyze changes in position between the results obtained in 3 over time using Ordinary Least squares model to determine the movement of the station.
The adopted method is therefore strictly a quantitative approach which could be summarized into four steps being:
COR station data download
COR station data post processing
Analysis of processed coordinates

Determination of station velocity and average error contributions in 3-D.
Observed station coordinates for same location taken at regular intervals over a period of time will have slight variation in obtained coordinates. The mean station coordinate for each day is

then analyzed in order to check for likely positional anomaly which might reflect processing error or gross station motion. In the event where such coordinates are however found to be consistent with oneanother, the observed coordinate variations are attributed to station motion. Having eliminated all known errors from observations within the COR Station network via the FKP, VRS and MAC techniques it thus becomes scientifically logical to attribute subsequent positional inconsistency at CORS location to station movement (building movements).
Furthermore, in order to account for possible un-modelled positioning error, a least squares approach has been designed in this study for extraction of station velocity as described in equations (1) – (6).
The observed positional difference is considered as a function of certain factors/parameters as shown in equation (1).

$$Observed\ positional\ difference = f\ (station\ motion, observational\ errors) \quad (1)$$

$$\Delta\ position = f\ (velocity, \sigma_{xx}\ , \sigma_{yy}, \sigma_{zz}) \quad (2)$$

But

$$dist\ (displacement) = velocity * time\ (vt) \quad (3)$$

$$\therefore \Delta\ position = vt + \Delta X + \Delta Y + \Delta Z + \epsilon \quad (4)$$

Where

$vt =$ Velocity component on station observation
ΔX = positional error in Easting = deviation of station reading from mean of observations
ΔY = positional error in Northing = deviation of station reading from mean of observations
ΔZ = positional error in Height = deviation of station reading from mean of observations
ϵ = observational noise

Using the conventional ordinary least squares as given in equation (5)

$$X = (A^T P\ A)^{-1} A^T P\ L \quad (5)$$

Where

$A =$ Design matrix (matrix of time and standard deviations of observed positions from their mean value)
P = Weight matrix = inverse of standard deviation of observations (σ^{-2})
L = vector of observations (displacement)
A^T= Transpose of the design matrix
X = vector of parameters (station velocity in, observational error in the East, North and Height directions)

$$displacement = \sqrt[3]{(X_n - X_{n+1})^2 + (Y_n - Y_{n+1})^2 + (Z_n - Z_{n+1})^2} \quad (6)$$

Where

X_n = Easting observation at the nth (initial) epoch
X_{n+1} = Easting observation at the nth + 1 (next) epoch
Y_n = Northing observation at the nth (initial) epoch
Y_{n+1} = Northing observation at the nth + 1 (next) epoch
Z_n = Height observation at the nth (initial) epoch
Z_{n+1} = Height observation at the nth + 1 (next) epoch

RESULTS AND DISCUSSION OF RESULTS

The processed coordinates across the 365 days vary haphazardly about the mean. A summary of the spatial behavior of the coordinates in 3 dimensions is presented in table 1 (a) and 2 (b)

for 2011 and 2012 respectively. As further indicated by the graphical plots, the height data experienced the greatest variation with data range as high as 15m in 2011 and 8m in 2012. This behavior is expected and confirms theoretical claims that the height processing from GNSS is subject to larger errors due to its consistently poor vertical dilution of precision (VDOP). This poor VDOP is consequent upon the fact that height observations are always based on satellite geometry on a single side (above the horizon) while the satellite beneath the horizon which should complement the former to give an improved VDOP are naturally inaccessible. This remains a research area in GNSS studies that is yet to be concluded.

Table 1 (a): characteristics of processed coordinates for 365days in the years 2011 and 2012

	2011		**2012**	
	Mean	**Range**	**Mean**	**Range**
Eastings (m)	225158.7937	0.537	225158.8864	1.196
Northings (m)	1034494.863	1.525	1034494.771	3.126
Height (m)	258.877	15.355	260.020	8.747

Table above also indicates that the station coordinate variation is more in the year 2011 than in the year 2012. This might be due to improvements in the FKP, VRS and MAC correction parameters in the year 2012. This is due to the continuous improvements in the NigNET by the Office of the Surveyor General of the Federation (OSGOF).A graphical presentation of the time series behavior of the stations against the day of the year is presented in Figure 4 (a - c) for 2011 and Figure 5 (a - c) for 2012 in the Eastings, Northings and Height.

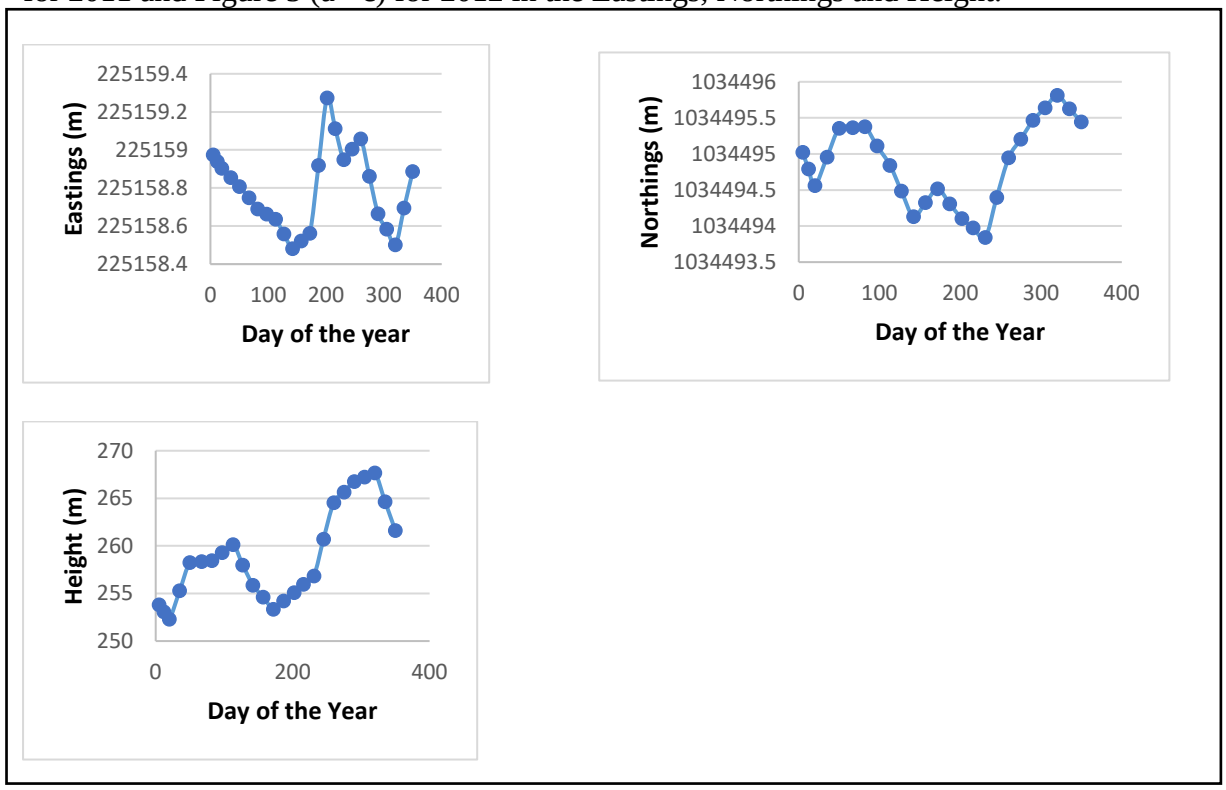

Figure 3: Time series plot (for the year 2011) of variations co-ordinates in

(a) Eastings (upper left), (b) Northings (upper right), (c) Height (lower right)

The graphs indicate a random behavior in the station coordinate variation. This observed pattern is as a result of a couple of factors which include:
Loss of required minimum satellite lock in between observations resulting in poor HDOP and/or VDOP at such times
Ionosphere / tropospheric delay model.
Possible errors in the choice of area correction parameters (FKP) used for the Nigerian CORS network adjustment.

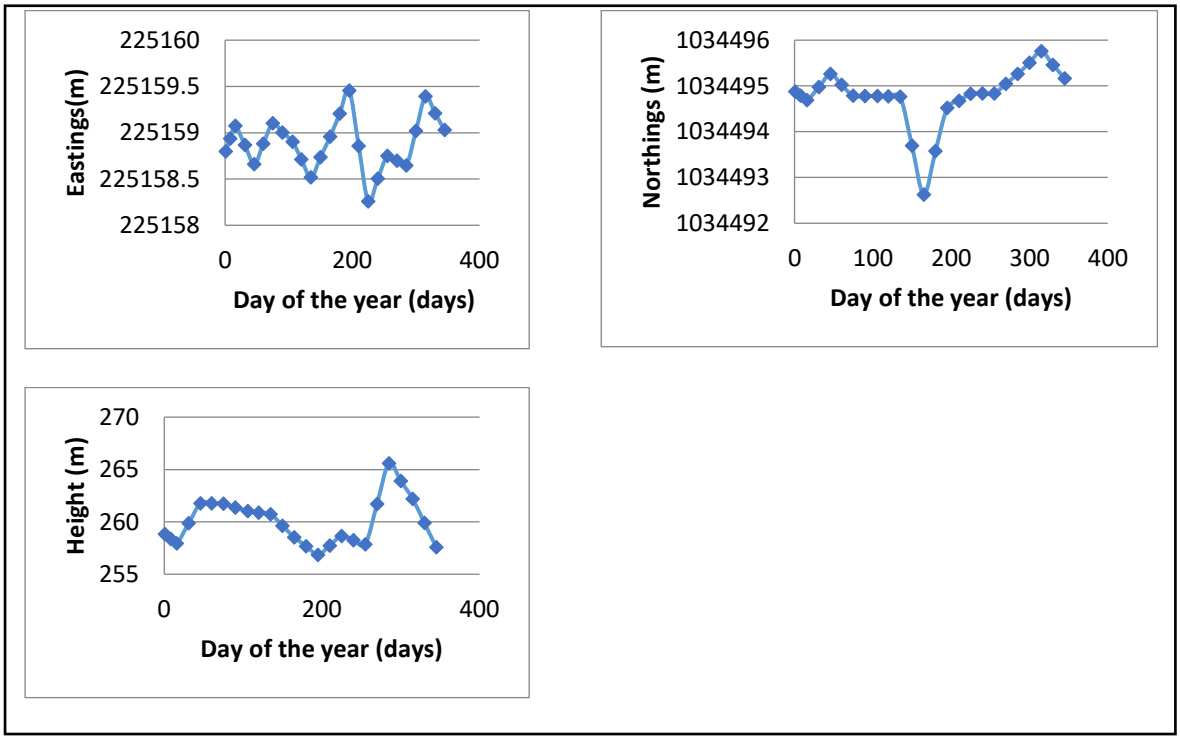

Figure 4: Time series plot (for the year 2012) of variations co-ordinates in

(a) Eastings (upper left), (b) Northings (upper right), (c) Height (lower right)

RESULT ANALYSIS

From equations (4) and (5), the velocity vector and average positional error at FUTY CORS for the year 2011 and 2012 were determined and the result presented in Table 2.

Table 2 (b): Summary of adjusted parameters for year 2011 and 2012

Results for Year 2011			**Results for Year 2012**	
Parameter	**Value**	**Units**	**Value**	**Units**
Velocity	0.00000023	m/s	0.0000002	m/s
Error_X	-0.002	m	-0.0005	m
Error_Y	0.003	m	-0.0002	m
Error_Z	-0.016	m	-0.0096	m
Analysis of adjustment			**Analysis of adjustment**	
min residual	-0.1697	m	-0.981	m
max residual	0.2928	m	0.196	m
mean	0.015	m	0.088	m
Standard dev	0.094	m	0.243	m

From Table 2 above, we notice a constant but insignificant value of the station velocity. It is therefore obvious that the station is stable and most of the observed coordinate variation are due to orbit and clock error. This is not "unlikely" especially due to the fact that the Nigerian CORS network is a "smoothed DGPS CORS" and the standard deviation of scalar positional accuracy is 0.5m (Schweigner et al, 2009).

CONCLUSION

The Federal Government of Nigeria has embraced the GNSS Technology (especially its application in Surveying and Mapping). The Office of the Surveyor General of the Federation should capitalize on this political will to fast tract the development of the new reference frame for Nigeria which will be consistent with the African Geodetic Reference Frame (AFREF) and the International Terrestrial Reference Frame (ITRF). By this meaningful collaboration, the use of CORS data for monitoring building stability, tectonic plate deformation and other such geodynamic applications could be properly implemented.

RECOMMENDATIONS

Based on the outcomes of this study, the following recommendations are presented:

1. Office of the Surveyor General of the Federation (OSGOF) is poised to come up with some urgent programme to support future enhancement of the NIGNET COR Station.
2. The Geospatial community should pursue the drive for the Installation of more COR Stations (at least four per state) subject to budgetary support.
3. Seek for collaboration and technical support from other Stakeholders within and outside the country in terms of capacity building, for efficient utilization maintenance of the NIGNET CORS network.

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Industrial Excavation Pits and its implications on enhancing Sustainable Land Management in Nigerian Cities: A Case Study of Bida Urban Area

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Abstract:
Distortion in urban landscape due to indoctrinate industrial excavations pose a serious threat to effective management of urban land resources in many urban cities in Nigeria. Several ditches (excavation sites) found in Bida are becoming awful risk to the community security and effective land management in the city. The study examined the implications of the indiscriminate industrial excavation sites on access to land and ecological security in Bida. The study has among its objectives; examined urban land management practices in Nigerian cities. It also identified misused urban land resources in Bida community in terms of indiscriminate land excavation pits. The study examined the implications of indiscriminate industrial excavation sites on sustainable land management in the study area. In achieving these, a number of Industrial excavation pits were visited, personal observations were made, coordinates and pictures were taking. The excavation sites in the study area were geo – referenced and Hand Held GPS was used to pick the width and depth of the excavation sites. Relevant agencies on land management and some District heads in the community were interviewed on process of land administration in the city. Findings from the study revealed that there is remarkable distortion on urban landscape which led to failure in urban physio - biotic. Similarly, there was outright deprivation to land for development as a stretch of borrow pits are commonly seen in some parts of the community. Recommendations proffered include; evolvement of regulations prohibiting the excavation of land within urban area by construction companies for the purpose of road construction. Excavation permit should be enforced by relevant Land Management Agencies on any site to be excavated outside the urban built up areas.

Keywords: *Urban Ecology, Industrial Excavation, Land Resources, Land Management, Physio Biotic.*

INTRODUCTION

There has been a grim exploration of available land resources within and at the fringe of urban settlements and the outcome is obvious in the deformation of urban landscape and its ecological composition. Brueckner et al (2001) asserted that urban growth resulting from population increase in urban communities in the recent years contributed immensely to the vanishing of an extremely limited number of urban natural resources. Similarly, the occurrence of irregular and unsteady urban development has gravely impaired land resources and the end product is apparent in various ecological imbalances noticed in all over the world. In support of this argument, Haddad, et al (2015) revealed that fragmentation of urban landscape resulting from poor land management has caused serious damage on urban ecosystems thereby reducing their encompassing structure and functions. Shlomo et.al (2012) observed that cities and metropolitan areas all over the word are now exceedingly fragmented with disconnected patches of urban fabric broken up by sheathes of vacant land. Antrop (2004) affirmed that the basic effect of urban growth in Europe is visible in the upsetting of ecological balance in urban areas. Berry (2008), also asserted that apart from the impairment of the working of the urban ecology, the fertile agricultural lands which are particularly impossible to recoup is left to degradation and vanishing.

In Nigeria, the effect of unguided urban growth goes beyond extinction of agricultural land; in many cases it hinders effective urban land management. Apart from these, the indiscriminate excavation of urban landscape caused more danger to the fragile urban ecological makeup. Soil crust that holds plant is lugged and deformed by industrial excavation thereby depriving the maximization of economic value of urban land resources. Personal survey also shows that most borrow-pits within and around urban settlements after heavy excavations provide hiding places for miscreants. Others are used as dumps sites (illegally) harbouring rodents and vectors that pose a great risk to community health.

In Bida, there are twelve excavation pits found within and around the community, mostly they were excavated for road filling during the construction of major roads within and outside the community. Unfortunately, eight of such wide and deep trenches are within the developed areas which pose a serious threat to the community security. Aside from being a threat, in some cases such places are sold out for housing by land speculators without considering the planning implications and during raining season properties are usually damped and sometimes flooded. Ecologically, the flow of interaction of urban landscape is impaired by these obnoxious depressions and the aesthetic communication that makes urban environment pleasant is however damaged. As long as the disruption on urban landscape continues, the urban physio – biotic composition becomes more dysfunctional and sustainable urban land management becomes unattainable. It on this backdrop that this paper examines the impact of excavation sites on urban land management in Nigerian.

Statement of problem

Land as a resource is provided by nature for the benefit of mankind; however the manner in which this resource is used do affects the continuous availability of the resource. This implies that, if land is not properly managed it could pose a great risk to community safety. The numerous excavation sites scattered indiscriminately in Bida urban centre has been a challenge to maximum utilization of land resources for economic and social growth. Such excavation pits could be found at the outskirts and the built up areas. Some are very deep and wide thereby denying the residents access to the use of such land for residential, commercial and any other meaningful purposes. An observation by the authors revealed that such excavation pits created some ecological threat to adjourning properties; as they are widened up year in year out by erosion eating aggressively towards buildings sited closed to the pits. Some have become perennial ponds of foul water that produces offensive odours within the neighbourhoods where they sited constituting a health risk to the residents. On the other hand, some have been turned to waste pits where household wastes and sanitary wastes are emptied thereby causing obnoxious site within the community. In some cases the presence of the excavation pits within some neighbourhoods provide a haven for miscreants where they carry out their evil activities and posing a security threat to the residents around such places. The study further reveals that the excavation pits were just abandoned without any statutory agency to manage the use of such places. They are left at the mercy of the land speculators who sell them without any regard to existing development control regulations, thus hindering the effective urban land management. Certainly, there is urgent need to address the problem of indiscriminate industrial excavation pits that is becoming a threat to effective landuse planning and management in Bida. It is on this background that the study attempts to examine the implications of indiscriminate industrial excavation pits on effective land management in Bida urban area.

Aim

The aim of this paper is to examine the impact of industrial excavation pits on urban land management in Bida with the view of advancing a sustainable land management strategy that will ensure a safer community.

Objectives

i. To achieve the aim of this study, the following subject matters were considered;
ii. The concept of Sustainable Land Management (SLM)
iii. Urban land management practices in Bida.
iv. Cases of poor urban land management in the study area.
v. The implications of indiscriminate industrial excavation pits on sustainable urban land management in Bida

Methodology

The study examined the implication of poor management of urban land resources on sustainable land management in Bida. Some scientific methods were employed to source relevant data needed for the success of the study.

Type of data

Data were obtained based on the objectives of the study, these include, information on land and management practice in the study area. Numbers, size and location of excavation sites were identified through a field survey. Data on various implications of industrial excavations on safety in the study area were also sources. The ecological risks experienced by residents around the excavation sites were also examined to determine the effect of the poor use of urban land resources.

Sources of data

Data were sourced from land management agencies in Bida including; Urban Development Board zonal office and Land office. Information was also sourced from some district heads on land allocation procedures within their area of juridiction. Residents whose properties are located in and around the excavation sites were also sampled to identify challenges experienced in such area. Some professionals in environmental sciences and health professionals were consulted on the implication of excavated site within urban community and possible ways of managing urban land to enhance sustainable land Management in Bida.

Instrument of data collection

1. Personal interview
2. The researchers had an interview with various land management agencies including Urban Board and Land Office both in Bida Town on land management practice in the study area. Also three (3) District heads were consulted to find out their roles in land alienation and management in their areas.
3. Use of questionnaire
4. For the purpose of the study, some wards were identified by the researchers based on their closeness to industrial excavation pits. From each wards, 10 families were sample randomly to establish the mode of plot acquisition, social and environmental challenges faced by the residents. Consequently, 120 copies of questionnaire were administered in all.
5. Personal observation

6. The various excavated sites in Bida were visited by the researchers and two field representatives to identify their locations, uses, conditions and their impacts on adjourning land uses. Some photographs were taken on site to show the magnitude of some excavation site and what they are use for.
7. Use of GIS application
8. The excavation sites within the study area were identified and a hand held GPS was used to pick their coordinates which also enabled their depth and width to be determined. The excavation sites were geo-reference using appropriate AG- SAT 7.3.

Sampling techniques and procedure

The excavation pits selected for the study were picked at random within Bida built up area considering their closeness and possible impacts they may have on adjoining properties and the community at large. On this backdrop, 12 wards where the pits are more prominent were selected for sampling.

REVIEW OF RELEVANT LITERATURE

Land provides a range of biophysical and socio economic goods and services that support the sustainability of the ecosystem, livelihoods and human well being. However the exploitation of land resources has cumulated to land degradation and desertification causing a huge threat to sustainable land management all over the world. According to a report from Economics of land degradation, about 10% to 20% of all land worldwide is degraded. This signifies that about 6-12 million square kilometres representing a quarter of the world's productive lands are degraded (Mikulka, Steward and Etter, 2015). Generally, Land degradation is the reduction or loss of the biological or economic productivity and complexity of rain-fed cropland, irrigated cropland, or range, pasture, forest or woodlands. This usually occur from natural processes, land uses or other human activities and habitation patterns such as land contamination, soil erosion and the destruction of the vegetation cover" (UN, 1997).

Inter Governmental Sciences Policy Platform on Biodiversity and Ecological Service (2018) revealed that about 3.2 billion people are affected directly or indirectly by land degradation. The consequences associated to land degradation are apparent in food and water insecurity and poverty as well as increase vulnerability to climate change effects. Other consequences identified by UNCCD (2016) include widespread of biodiversity and poor ecosystem services. Mikulka, el at (2015) asserted that, the annual global economic loss in 2008 due to deforestation and land degradation is estimated to the tune of 1.5 - 3.4 million Euros. From the foregoing, it is evident that land degradation is a serious threat that needs to be addressed so as to halt its devastating effect on socio-economic and human well being.

Environmental sciences (2016), identified the major causes of land degradation to include among others; land clearance such as clear cutting and deforestation, agricultural activities, irrigation, salinity and over drafting like extracting ground water and industrialization. Khresal (2014) from his experience on land degradation in southern Jordan noted that the nature of farming practices attributed to land degradation as it always lead to exacerbating pressure on land thereby increasing the degradation of land generally. He also identified non sustainable landuse practices, inadequate management of plant residues, overgrazing of natural vegetation, random urbanization and land fragmentation are other causes of land degradation in southern Jordan. European Environmental Agency (2017) attributed the problem of land degradation in

Europe to expansion of urban areas in terms of increase in roads, rails, industrial parks, housing and commercial zones that continuously consume land with productive soil. Consequently, Europe's agriculture land continues to decrease at an average of 1000 km per year (EEA, 2017). The structure and associated biodiversity as well as the traditional rural landscapes in Europe continue to be affected.

In Nigeria, causes of land degradation seem to be similar to any other places in the world. The causes of land degradation as observed by Imoke (2012) include; land clearance, poor farming practices, overgrazing, inappropriate irrigation and urban sprawl. Others include; commercial development, land pollution, quarrying of stone, sand and minerals Imoke (2012). In summary, the causes of land degradation as pointed out by various authors' shows that poor farm practices, urbanisation, deforestation, overgrazing quarrying, housing and commercial as well as increase in urban demand have greatly impacted landscape structure and formation which consequently lead to land degradation. However, the effect of indiscriminate land excavation on urban landscape was not appreciated much by the authors. Imoke (2012) was close to this but his emphasis was on quarry of stone and sand. Any urban land management strategy that fails to give appropriate attention to the impact of indiscriminate industrial excavation pits found everywhere in urban communities may not achieve the level of sustainability intended. It is on this backdrop that this paper attempts to assess the implications of industrial excavation pits on sustainable urban land management.

CONCEPT OF SUSTAINABLE LAND MANAGEMENT (SLM)

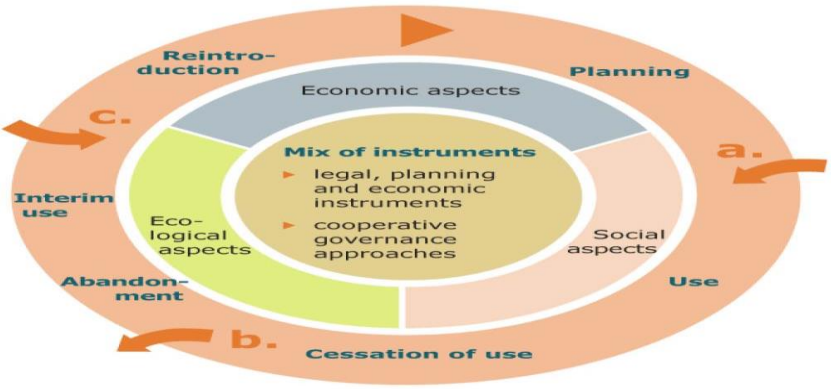
Smyth and Dumanski (1993) defined sustainable land management as an approach that combines technologies polices and activities that bring about socio economic principles with environmental issues that enhance production but at the same time reduces degradation to the environment and natural resources. Sustainable Land Management (SLM) on the other hand entails "the use of land resources, like soils, water, animals and plants, for the production of goods to meet the changing human needs while ensuring the long-term productive potentials of these resources and the maintenance of their environmental functions (FAO, 2020). Similarly, Sustainable Land Management as defined by TerrAfrica in FAO (2020) is the adoption of land use systems that, through appropriate management practices, enables land users to maximize the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resources.

Sustainable Land management encompasses established approaches on soil and water conservation, natural resource management and integrated landscape management (FAO,2020). It involves a holistic approach to achieving productive and healthy ecosystems by integrating social, economic, physical and biological needs and values towards enhancing sustainable land resources planning and management. Consequently, efforts to deal with land degradation through SLM must address water scarcity, soil fertility, organic matter and biodiversity. SLM best practices upscale sustain and improve livelihoods while protecting the land's resources and ecosystem functions. It seeks to increase production including traditional and innovative systems and to improve resilience to food insecurity, land degradation, loss of biodiversity, drought and climate change (Hurni,1997) .

'3 Es' of sustainable Land Management

From the view of Hurni (1997) there are three fundamentals of Sustainable Land Management which are economy, ecology and socio-cultural. UNESCO (2006) also corroborated with these

and referred to them as the '3 Es' of sustainable land management which include as Equality, Economy, and Ecology. The ecological dimension of sustainable land management entails the consideration of biological diversity of land resources as a reason for effective preservation and management of available land. The Social element of sustainable land management deals with securing and enhancing sustainable livelihoods by scaling up soil productivity, thereby improving food security and addressing poverty, both at household and national levels. Similarly the Economic dimension of sustainable land management focuses on the issue of pay back investments made by land owners and the communities at large. To this end, the emphasis is to promote sustainable access to land for the benefit of present and future users for shelter, public investment and community services. Scaling-up of sustainable land management in this regard brings about more quality benefits to more people over a wider geographic area more quickly, more equitably and more lastingly (Ileia, 2001). The adoption of the three essentials stand as the platform for ensuring effective land management and this is illustrated in the Figure 1 as presented by German Institute for Urban Affairs.



a. Zoning new "greenfields" (to minimize)
b. Rejection of land not suitable for subsequent use
c. Activating land potentials (to strengthen)
- brownfields (industrial, commercial, military)
- gaps between buildings in internal areas
- urban renewal sites
- sites under going planning

Source: German Institute of Urban Affairs (Difu 2005).

The model was adopted in this study to examine the impact of indiscriminate excavation of urban land in Bida as it influences sustainable land management in Bida urban area. Figure 1 shows the sustainable land management model presented by German Institute for Urban Affairs. The sustainable land management is presented in three circles having an inner circle which comprises major instruments for ensuring effective land management in a locality. The instruments as presented by German institute of urban affairs include; Legal, planning and economic approaches as well as cooperative governance.

The second circle next to the inner circle, takes care of the basic 3 aspects of sustainable land management and these includes; social aspect, economic aspects, and ecological aspects

The third circle which is the outer circle illustrates directions upon which urban land can be categorized for effective management. It brings to bear a zoning process under which land can be classified. For instance, German institute of urban affairs (2005) classified urban land into 3 classes tag as "allowable and unallowable uses". The class "a" covers portion of urban land meant for planning use with ultimate care to minimize the use of the land. It conserved such

area like new zone green field and emerging area. The class "b" covers portions of urban land under cessation, abandoned and those portion having interim use. The class "c" stands for such urban landscapes that are subject to reactivation so as to strengthen the social economic potentials of the land. Such areas include; industrial zone, commercial zone, and military zone, it could also include urban renewal site and so on.

RESULT AND DISCUSSIONS

Land management in study area

The manner of land administration in the study area is similar to land management practices in other cities in the North. Generally, the administration of land is more of customary land tenure systems which relate more to the practices of land holding. According to Mabogunje (2007), the problems of actual inheritance claim and gender issues, owner/tenant issues, and traditional pledging system are the characteristics of this type of urban land management in Nigerian. It is still a common practice in Bida urban areas to see individuals or families having strong control on portions of land which encourage land to be individualized, bought and sold within the city. Table 1 show the source of plots acquisition in selected neighbourhoods.

Table:1 Sources of plot acquisition in Bida urban area.

Name of wards	Sources of plots acquisition the study area				
	Land office	District head	Family inheritance	Land agents	Total
Dikoburoro1	4	1	-	5	10
Masaga1	-	1	8	1	10
Dikoburoro2	6	3	-	1	10
Bantigi	-	-	10	-	10
Dikoburoro3	2	3	-	5	10
Masaga2	-	2	6	2	10
Bangaie1	-	3	7	-	10
Bangaie2	-	1	8	1	10
Nasafu	-	4	4	2	10
Ebosoko	-	6	-	4	10
Area8 (a)	4	2	-	4	10
Area8 (b)	4	3	-	3	10
Total	20(16.6%)	29(24.2%)	43 (35.8%)	28(23.3%)	120

Source: Author field survey, 2020

It obvious from Table 1 that 35.8% of the residents acquired their residential plots as family inheritance. Similarly, 23.3% acquired their plot from Land agents while 22.5% got theirs through District Heads and only 16.6% acquired their plot officially from Land office.

The study revealed that district heads, land agents and families play strong roles in land management in Bida urban area. This explains the reason why land administrative agencies find it difficult to manage the use of urban land efficiently in Bida.

Poor land management in the study area

The essence of this part of the study is to identify some areas of land mismanagement in the study area. In this case a classification strategy was adopted where land in the study area was grouped into developed areas, developable areas and deprivation areas. The developed area comprises of the land portion built up for residential, commercial, industrial, education,

administrative, recreational, community facilities and open spaces within the city. This class as illustrated in Table 1 covers 86,258 hectares amounting to 50.8% of the total landmass. The developable areas comprised of the vacant land within the city and the farmland at the outskirt the city. This class on the other hand covers about 77,259 hectares amounting to 45.5% of the total landmass. The deprivation areas are such land areas that cannot be used directly for any development in their present state. They include; natural depressed sites, industrial excavated sites, gully erosion sites and dump sites. This class accounted for 3.7% of the entire landmass covering about 6,283 hectares and among this class, industrial excavation sites covers large proportion. Table 2 shows the classification of Bida urban landscape.

Table 2: Bida urban landscape classification

Classes	Area coverage in Hectare	%
Developed Area	86,258	50.8
Developing Area	77,259	45.57
Deprivation Area	23,263	13.7
Total	169,800	100

Source : Authors' Field Survey 2019

From the analysis, it is obvious that a sizeable proportion of Bida landscape could be consider as deprivation land area.

Industrial excavation sites in Bida urban area as part of deprivation areas

As revealed from the survey, close to 5% of Bida's landscape is lost to indiscriminate excavation pits within the built up area. Figure 2 shows some excavation sites across Bida urban area.

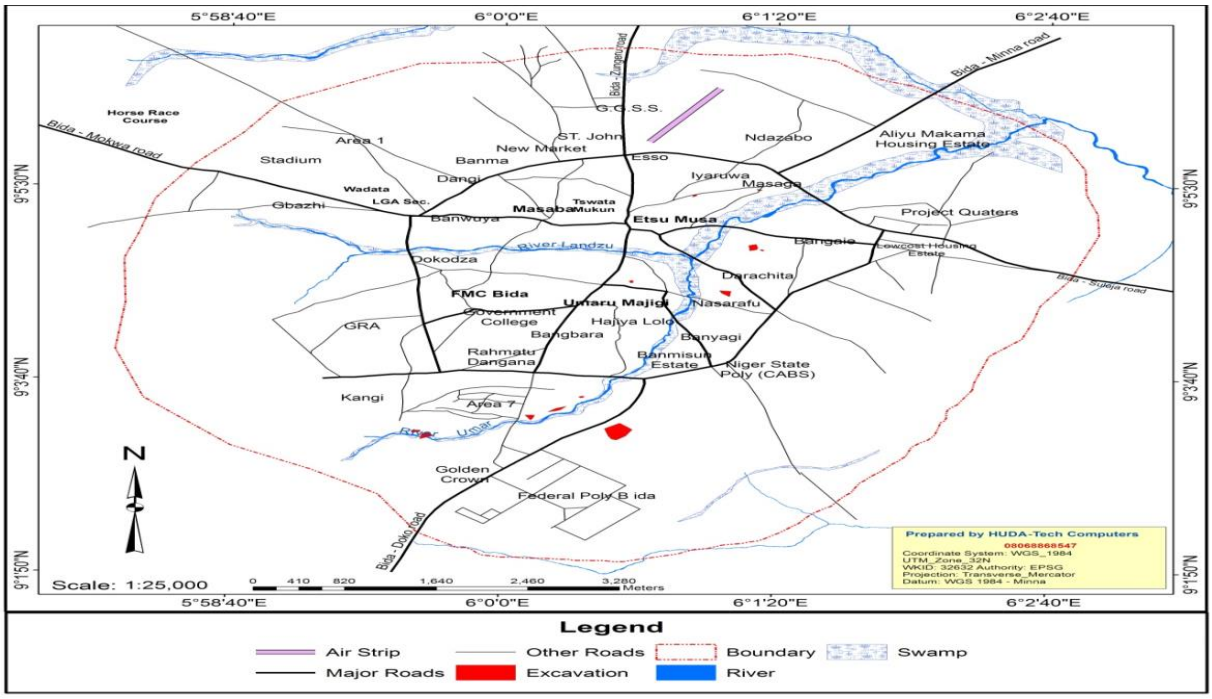


Figure 1: The location of some Excavation pits in Bida urban area.

(a). Locations of some Excavation pits in Bida

The study also reveals that there are 12 major excavation sites within the built up area as shown in figure 1. They can be found in the following areas in the study area as listed in Table 3.

Table 3; Location and spatial cover of each excavation pits in the study area,

S/N	Name of wards	X	Y	Area in Hectare
1	Dikoburoro1	170439.279	1002299.245	0.43
2	Masaga1	171914.9721	1006175.544	0.09
3	Dikoburoro2	170684.1273	1002440.402	0.47
4	Bantigi	171346.1909	1004674.548	0.12
5	Dikoburoro3	170900.6549	1002652.684	0.10
6	Masaga2	172495.6408	1006278.086	0.08
7	Bangaie1	172439.5072	1005270.422	0.68
8	Bangaie2	172517.9548	1005222.19	0.06
9	Nasafu	172192.6399	1004467.896	0.62
10	Ebosoko	171227.5633	1002047.614	4.43
11	Area8 1	169508.6204	1001979.965	0.75
12	Area8 2	169414.6205	1002055.868	0.28
			Total	**8.11**

Source: Authors' Field survey, 2019

The excavation pits can be found in Dikoburoro ward 1 and 2 and 3 Masaga 1 and 2, Bangaie districts 1 and 2, Buntugi area, Nasafu area, Ebosoko area and the new developing areas called Area 8. Figure 1 shows the locations of the excavation pits as sighted in various districts. Table 3 shows the spatial extent of each excavation pit for instance in Dikibororo wards about 1 hectare of land is lost to excavation pits. In Bantigi, Bangaie and Masaga wards a total of 1.2 hectares of land is wasted. Similarly, Ebosoko, Nasafu and Area 1 and 2 lost about 6.8 hectares to excavation pits.

(b). Depth and locations of some excavation pits in Bida

The depth of the excavation pits were measured during the survey using handheld GPS which shows that as wide as some of the excavation pits are so deep are they.

Table:4 The depth and condition of excavation pits

S/N	Name of wards	Depth of excavation pits (m)	Condition of pits
1	Dikoburoro1	15.8	vacant
2	Masaga1	10m	Filled with solid waste
3	Dikoburoro2	12.85	There is an uncompleted building
4	Bantigi	2.8	Filled with waste water and trash
5	Dikoburoro3	11.3	vacant
6	Masaga2	4.5	Filled with waste water and
7	Bangaie1	12.1	Filled in water and waste plastic containers
8	Bangaie2	6.2	Used for dump site
9	Nasafu	18.6	Has become a pond of water
10	Ebosoko	6.7	Some building are coming up here
11	Area8 1	7.1	Vacant
12	Area8 2	5.2	vacant

Source: Authors Field Survey, 2020

As revealed in Table 4, the depths of the excavation pits in Dikobororo wards are 15.8m, 12.85m and 11.3m. The excavation pits in Massaga ward 1 and 2 measred about 10m and 4,5m respectively while Nasafu has the deepest excavation pit measuring 18.6m. The excavation pits in Bangaie ward 1 and 2 has the depth of about 12.1m and 6.2m while the ones in Area 1 and

2 range between 7.1m and 5.2m. from the foregoing it is evident that some of the excavation pits cannot be used for meaningful development in their present state.

(c) Conditions of the pits.

Table 4 also revealed the various conditions of the excavation pits in Bida urban area. Mostly the pits are filled with waste water, all sorts of trash and weeds. In Dikobororo ward 2, three residential properties were spotted, one is occupied, one seems abandoned and the other one is still under construction. It was also observed that some are used as dumpsite while some are vacant and youth and children in the neighbourhoods use them as playground.

Plate i : An Excavation pit in Bangaie filled with stagnant water and plastics containers

Figure 3: A building under construction In an excavation pit Dikobororo ward 2

(d) Challenges encountered by residents living around the excavation pits.

An interview with some residents selected at random around the excavation sites revealed some experiences the residents pass through from time to time. Among the challenges highlighted by the residents; include flooding during the wet season, erosion and building collapse, incessant dampness of houses resulting to peeling and cracks of plastered walls around the excavation sites. Other challenges experienced among those leaving around excavation sites include; lost of valuables to theft, obnoxious sight and smells, harassment and poor access to their properties.

Table 5 Challenges encountered by residents living around the excavation pits

S/N	Name of wards	Poor accessibility	Insecurity	Erosion and Flooding	Dampness	Collapse of buildings	Obnoxious Sight and smell
1	Dikoburoro1	1	2	2	1	3	1
2	Masaga1	-	2	3	2	-	3
3	Dikoburoro2	2	2	3	2	1	-
4	Bantigi	2	1	4	3		
5	Dikoburoro3	3	4	1	1	1	-
6	Masaga2	-	-	1	3	-	6
7	Bangaie1	4	1	3	1	-	1
8	Bangaie2	-	2	1	2	1	4
9	Nasafu	2	2	3	1	-	2
10	Ebosoko	4	2	2	2	-	-
11	Area8 1	1	3	2	2	-	2
12	Area8 2	2	5	1	1	-	1
		21 (17.5%)	26 (21.6%)	26 (21.6%)	21 (17.5%)	6 (5%)	20 (16%)

Source: Authors Field Survey, 2020

Outcome of interaction with Professionals

The views of some Professional in the Environmental sciences were sought on the implications of industrial exaction pits on sustainable urban land management in Bida. Most implications mentioned by the professionals include; the issue of land deficit in Bida township where considerable land space in the affected neighbourhoods is lost to massive depression resulting from quantum industrial excavations. Another implication noted is incidence of gully erosion occasioned by excavation pits around residential neighbourhoods in Bida thereby worsened the problem of erosion in the community. One of the professional observed that there is a case where some buildings and fences collapse as a result of expansion of excavation site by erosion. Figure 3 shows an abandoned structure with some parts falling inside an excavation pit.

Figure 3: an abandoned structure beside an excavation pit with some collapsed parts in Dikobororo area

Another implication mentioned by the professional is distortion in physio-biotic flow of urban landscape. According to them the natural land surface in every place spread out in a panoramic outflow which portrays an uninterrupted physical interaction among land elements and boost `land stability to withstand external pressures. This flow is distorted through industrial excavation thereby causing deformation of the natural land compartment and management. Depletion of urban vegetation was also identified as part of the implication of indiscriminate industrial excavation sites on urban land. The excavation of borrow pits in built up area do not only affect the urban scenery, the removal of numbers of trees during excavation in one way or the other contribute to de-vegetation and extinction of species of tress like Neem trees, date palm, Mango trees among others which are common species found in some neighbourhoods in Bida. Other implications as noted by the professionals include; Environmental health risk and threat on urban infrastructure.

FINDINGS

- Multiple controls over land in the study area make the effective urban land management difficult.
- About 14% of Bida urban land can be described as deprivation area and close 5% of such area is lost to industrial excavation pits.
- Industrial borrow pits in Bida urban neighbourhoods pose serious environmental risk to the residents.
- The implications of poor urban land management in Bida in terms of indiscriminate industrial excavation pits include; problem of land deficit, incidence of gully erosion, distortion in physico – biotic flow of urban landscape, gradual de-vegetation of urban area and grave threat to urban infrastructure.

CONCLUSION

The risk posed by poor urban land management resulting from indiscriminate excavation of urban land for road construction has impacted grave distresses on urban landscape, urban ecology and urban residents. Unfortunately not much of the problems ensuing from indiscriminate excavation pits are perceived by many. This explains why no attention has been given to the need for appropriate management of excavation pits within urban built up areas. The outcome of this study revealed the hazardous ecological imbalances that threatening the city of Bida as a result of indiscriminate excavation pits scattered all over the city. In attempt to address these imbalances the following recommendations are suggested. There should be a regulation prohibiting the excavation of land within urban area by construction companies for the purpose of road construction. There should be excavation permit to be enforced by relevant land management agencies on any site to be excavated outside the urban built up areas. There should be a permissible distance determined by relevant agencies within which industrial excavation should not be allowed. Urban Ecological Base Plans should be produced and submitted by any construction company for the site to be excavated. The plan should comprise details of how the site will be consciously and effectively managed after the excavation operation. This will help in preserving urban landscape, enhance safer cities and ensure effective management of urban land. However, the existing excavated sites within Bida built up areas should be put under surveillance to avoid misuse either as dumpsite or for residential plot. Such places should be landscaped and be converted to light recreational land use.

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SUB-THEME 7:
RAPID URBANIZATION, SUSTAINABLE LAND USE AND SPATIAL PLANNING

Influence of Igala Culture on Spatial Relationships and Space Distributions within Households in Anyigba Kogi state

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Abstract:
Cultural influences over spatial relationships for a long time have been an aspect of architecture well researched, unfortunately there exist limited studies on the architecture of the Igala people. This study assessed the cultural factors within the Igala kingdom which affects spatial relationships and organisations within some selected households in Anyigba. Four main settlements exist in Anyigba namely; Iji, Aji-Tachi, Obeya and Egume-Ankpa Road. Qualitative approach to data gathering was used in the form of participant observation and interviews. The collation of data also included sketches of household floor plans which were comparatively analysed, the content analysis of the data showed that security and privacy constituted the main factors in the planning of a typical compound. It was also established that the most important space interms of the frequency of use is the Atakpa, the relaxation hut located in the middle of the household. This study hereby recommends to built industry professionals, developers and Igala indigenes to incorporate these factors into any proposed development of a household so as to preserve the cultural influence of the Igala people in its architecture.

Keywords: *Spatial Relationships, Cultural Factors, Sustainable, Igala, Architecture.*

INTRODUCTION

The influence of culture on the relationship between uses of space is not in doubt and as such dwelling spaces conformed to the way of life of the people who inhabit such spaces, (Dejbakhsh et.al, 2011). Existing studies have established that culture plays a great role in determining the spatial relationships within households (Fathy, 1978: Kent, 1990: Adler, 1992: Torabi and Brahman, 2013). As such the household is a major portrayal of culture and depiction of spatial relationships of all cultures (Eriksson *et al*., 2017).

The United Nations Educational, Scientific and Cultural Organisation, (UNESCO) has advocated for the preservation of cultural values in both tangible and intangible forms (UNESCO, 2006). The preservation of cultural heritage are more pertinent in the minority ethnic groups such as the Igala due to the acculturation of the three main ethinic groups of Hausa, Yoruba and Igbo in Nigeria (Muhammad 2017).

It is to be noted that the design and structure of households within the Igala kingdom has undergone considerable modifications due to technological advancements, urban migration and influence of other cultures (Emusa, and Nduka 2018). Significant influences from the Hausa and Nupe ethnic groups have had a great impact on the Igala people and their culture (Forde et.al, 2017). However, irrespective of these influences on the Igala culture, it is expected that the cultural atributes of space utilisation are never completely lost.

Isah (2016) believes that no matter the influence a culture is subjected to such cultures can always be regenerated, more also is the fact that Igala people have been described as highly conscious of culture irrespective of their social status and religion (Yunusa, 2012, Ukwede, 2014, Emusa and Nduka 2018). Despite the assertion of these studies, there still exist a gap in the understanding as to what extent cultural factors play in determining the spatial relationships within households in Igala land.

Influence of Culture on Spatial Relationships and Organizations in Households

Askarizad (2017) postulates that architecture is a body with various faces hence its functionality transcends all of humanity, culture, belief, family and environmental conditions. This statement has shown that architecture can properly be referred to as cultural because its procedure and body are influenced by the characteristic principles applicable to culture. This relationship between architecture is further elaborated in the spatial planning, relationships and organisations of spaces within a given community (Hilier et .al. 1987).

Torabi and Brahman, (2013) are convinced that for a given household most spaces considered useable or rather functional are tied to culture, citing examples of Iranian households designed to cater for three generations by exploiting the open spaces to accommodate new members of the family. The Iranian experience as described by Askarizad (2017) believes that the open courtyard and large walkways in most traditional Iranian houses enable families to grow in size with the surrounding environment. Similarly in the context of Nupe ethnic group in Nigeria, the concept of family growth is based on "*efako"* in which a family may not necessarily be constituted on blood relations (Muhammad, 2017). As such, each culture perceive the world differently and thus the interaction with space is different (Ko & Son, 2018; Smith, 2008).

Spatial relationships within households emphasizes the design and blueprint of spaces inorder to accomplish a particular goal that amplifies the frequency and type of communiqué between architectural and cultural elements in a household (Torabi and Brahman, 2013). Hilier et al. (1987) postulates that spatial relationships dwell more on the organization of spaces to achieve functionally organized settings, hence social relations which has been determined by cultural factors influence the creation of space and spatial organizations within that household. This explains why Mahdavi and Yarmud (2013) enthused that spatial concepts such as passages, balconies/veranders, and courtyards serves as measures to evaluate cultural influences on spatial relationships within a household.

The architecture of culture in most African societies enumerates the living styles, occupation and social interractions within people in these settlements (Zaslavsky, 1999). And in Nigeria and mostly the north central region where the Igala people are located the architecture is a true reflection of the living style and organization of spaces within the region (Mai and Shamsuddin, 2008). The people within this region generally have a space where guests are entertained while other spaces are gender defined with women located a distance away from the spaces within the households (Muhammad, 2017). It can hence be deduced that spaces for most of the activities are defined by the social relations which would be undertaken in these spaces, in which case names of these spaces will differ in different ethnicities along the North central region but the activities carried out are all the same depending on the social function.

Across northern Nigeria and mostly within the north central region, religion was identified as a major factor which influence the architecture of the settlements and households (Danja *et.al*, 2017). The religion of the household determine where and how a new household is formed with consideration given to the possibility of a Mosque for the Muslim faithful while Christians would earmark a location for prayers. Additionally Agboola and Zango, (2017) observed that location of individual buildings are mostly often designed to shield the accomodations of women from public scrutiny. The designs of these women buildings are positioned in such away that these women can be part of the activities within the household, this explains why women accommodation are arranged far from public social activities in a household.

The Zaure influences the way the hausa's design and build their houses (Babaginda, 2011), for the Nupes, Katamba, a hut located at the entrance of the household which serves the dual purpose of receiving and entertaining visitors plays similar role which the *Zaure* plays in Hausa

Architecture (Muhammad, 2017). Due to the influence of hausa architecture on the Igala people coupled with similar lifestyle and ancestral relationships between the Igala people and Nupe people it would not be far fetched to imply that the Igala people might have a similar structure playing the same function or a similar function to the *Zaure* and *Katamba*.

Study Area

Igala is an ethnic group located in Kogi State, North Central, Nigeria. The geography of Igala land can be located on latitude 6°30 and 8°40 north and longitude 6°30 and 7°40 east and covers an area of about 13,665 square kilometres (Emusa and Nduka, 2018). Boston (1967) believes that the people of Igala origin are of proto-kwa origin. Akinkugbe (1978) on the other hand addressed the Igala origin from the perspective that there exist some core lexicostatistic similarities as well as sound shifts and etymological innovations between the Igala and the Youruba people of the south-west of Nigeria. These cultural similarities can also be observed to include traits and attributes in the form of kingship and marriage.

Anyigba is a major town in Igala land located in Dekina Local Government Area. Its average altitude is about 420 meters above sea level, falling between the tropical wet and dry climatic region and the guinea savanna, having mean annual temperature of 25ºC and rainfall 1600mm (Ifatimehin and Musa, 2011). Relative Humidity generally rises to over 80% and falls between 50%-70% in the afternoons during the wet season. Rainy season occurs between April through October and the peak is September the rains are mainly of the conventional type (Awosusi and Oriye, 2015). Anyigba is mainly an agrarian society which is currently evolving towards commercial due to the presence of the University.

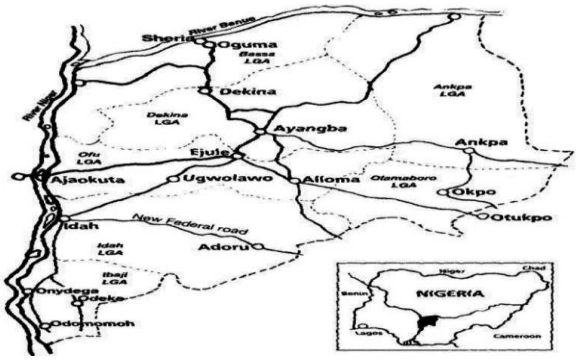


Fig 2: Map of Igala Land.
Source: (Emusa and Nduka, 2018.)

METHODOLOGY

Data Collection

Qualitative approach to data sourcing in the form of observation and interviews, were employed as instruments for collating data. A total of forty houses were visited for observation purposes, these houses comprising of ten each from the four settlement areas in Anyigba namely: *Iji*, *Aji-Tachi*, *Obeya*, and *Egume –Ankpa* road were randomly selected and comparatively analysed. From these forty houses observed, floor plans of the different household types were sketeched inorder to understand the spatial pattern of the homesteads within Anyigba, futhermore eight residents were interviewed in order to have insight into the intangible aspect of the spatial interactions within the domestic space.

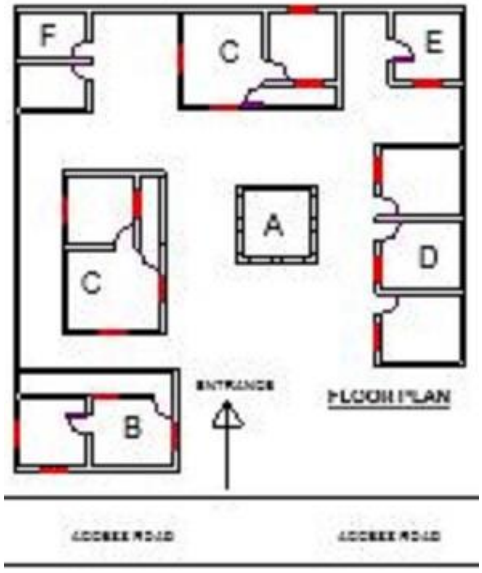
Questions were administered in open ended format focussing on what constitutes the important spaces for a typical Igala household, additionally behavioural mapping of space utlisation by the members of a typical household was employed to ascertain cultural influences on useable spaces.

Data analysis

The key data collected were through interviews, observation and behavioural mapping. Firstly the interviews collected were transcribed into text and content analysed towards development of key attributes that constituted key themes in spatial interactions. These key attributes were thereafter triangulated with the findings of observation and behavioural mappings carried out.

Results and Discussion

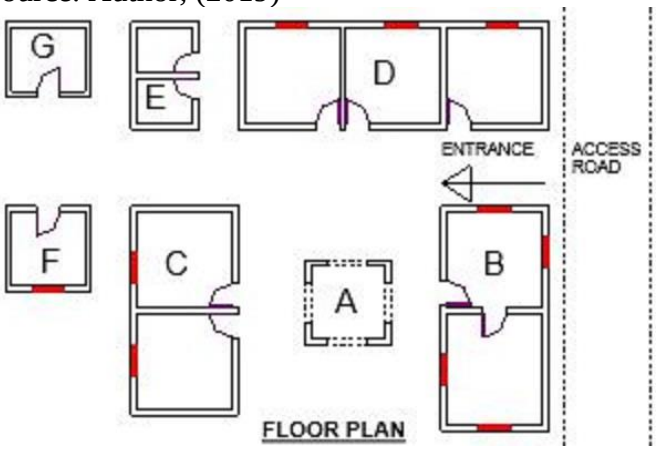
It has been established that the domestic space constitutes one of the major feature that gives a window to understanding culture and space relationships of people. From the floor plans sketched the different spaces within a typical household were displayed in tabular form. Interviews conducted with various respondents was able to help with the underdtanding of these spaces and its uses. Sketches of these floor plans are presented below from which tables were drawn up in order to depict the percentage influences of each cultural factor as it affects households.



LEGEND

A	ATAKPA
B	UNYI-ENEGBANI
C	UNYI-UBOBULE
D	UNYI-ABOKELE
E	OBUKA
F	UNYI-UGWOLA

Plate III: Typical Floor plan of Iji-Community
Source: Author, (2019)



LEGEND

A	ATAKPA
B	UNYI-ENEGBANI
C	UNYI-UBOBULE
D	UNYI-ABOKELE
E	UNYI-UGWOLA
F	OBUKA
G	UNYI-ENO-ERE

Plate IV: Typical Floor plan of Aji-Tachi and Obeya Community
Source: Author, (2019)

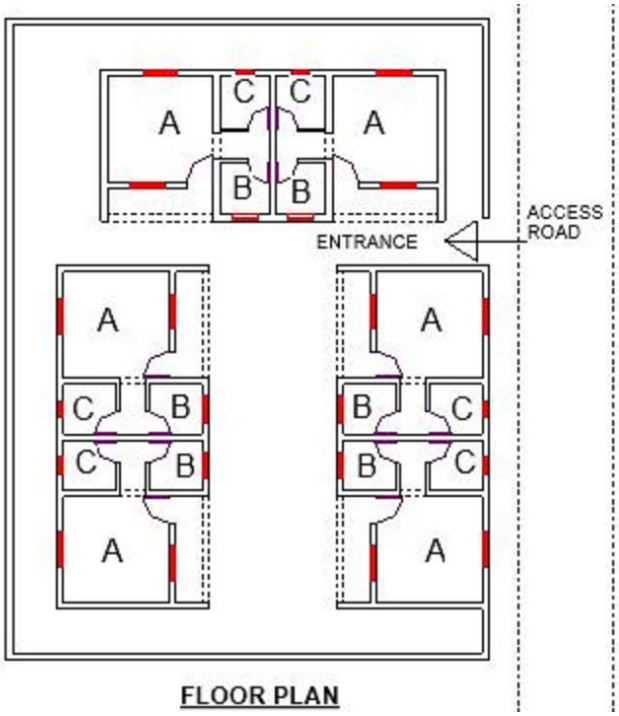


Plate VI: Typical household Plan at Egume-Ankpa road
Source: Author, (2019)

Table 1: Available Spaces within households in Anyigba

SPACE DESCRIPTION	IJI COMMUNITY	AJI-TACHI COMMUNITY	OBEYA COMMUNITY	EGUME-ANKPA ROAD COMMUNITY
UNYI-ENEGBANI (Household head)	Available	Available	Available	Available
UNYI-UBOBULE (Female Quarters)	Available	Available	Available	Not Available
UNYI- ABOKELE (Male Quarters)	Available	Available	Available	Not Available
ATAKPA (Relaxtion/ Reception Hut)	Available	Available	Available	Not Available
OBUKA(Kitchen)	Available	Available	Available	Available
UNYI- UKWOLA (Bath/Toilet)	Available	Available	Available	Available
ACHEKWU (Shrine)	Not Available	Not Available	Not Available	Not Available
UNYI-ENOERE (Animal Barn)	Not Available	Available	Available	Not Available

Source: Author, (2019)

Table 1 above shows the typical spaces found in an Igala household, the most common spaces are *Unyi-Enegbani, Obuka and Unyi-Ukwola.* This suggests that the Igala people believe that every household must have a head to organize the household a kitchen to prepare food and a place to bath. The *Atakpa*, *Unyi- Abokele* and *Unyi- Ubobule* were discovered to be present in three settlements apart from the *Egume-Ankpa* road settlement, this is because the Ankpa-Egume settlement have mainly households built to cater for the student population. *Achekwu* was not found in any of the settlements. *Unyi-Enoere* was only seen sparingly in two communities this is as a result of constant unexplained disappearance of domestic animals as

proffered by Respondent R1, who said "*we hardly keep animals as they end up dying or being stolen".*

Table 2: Observation Schedule of Cultural factors as they affect spaces within households in Anyigba

SPACE DESCRIPTION	**IJI COMMUNITY**	**AJI-TACHI COMMUNITY**	**OBEYA COMMUNITY**	**EGUME-ANKPA ROAD COMMUNITY**
ATAKPA	Available	Available	Available	Not Available
SECURITY/ PRIVACY	Available	Available	Available	Available
ACHEKWU (Shrine)	Not Available	Not Available	Not Available	Not Available
WINDOW OPENINGS	Large window openings	Large window openings	Large window openings	Large window openings
TOILET/ BATH	Not within the households	Not within the households	Not within the households	Within the households

Source: Author, (2019)

Table 2 above establishes that the most common cultural factor influencing the four settlements is security and privacy all the settlements have its households designed to be aware for privacy and security concerns. The *Atakpa* is prevalent in three settlements suggesting that it is a common cultural factor to the igala people. Achekwu has disappeared from the households within Anyigba while the window openings and door sizes are no longer small. Most of the households in Anyigba have the toilet and baths located outside the sleeping quarters except for households in Egume-Ankpa road settlement.

Table 3: Percentage Influence of Cultural Factors as they affect Households in Anyigba

S/NO	**COMMUNITIES**	**CULTURAL FACTORS**				
		Atakpa	Security / Privacy	Achekwu (Shrine)	Large Windows	Toilet located within Household
01	Iji Community	**8**	**10**	**0**	**8**	**2**
02	Aje-Tachi Community	**9**	**10**	**0**	**8**	**2**
03	Obeya Community	**9**	**10**	**0**	**2**	**1**
04	Ankpa-Egume Road Community	**2**	**10**	**0**	**8**	**9**
	Total	**28**	**40**	**0**	**26**	**14**
	Percentage	**26%**	**38%**	**0%**	**24%**	**13%**

Source: Author, (2019)

The table above illustrates the percentage influences of established cultural factors amongst the Igala speaking people of Anyigba. Security and privacy has the highest percentage which shows that the Igala people have a very high regard for privacy and security within its households, this security and privacy was ascertained from the locations of the individual units as they relate to one another. The *atakpa* comes next in terms of percentage influence which emphasize the importance this hut plays for the Igala people. Window and door sizes which were thought to be small in size were actual not so but larger and plays a relative role as a cultural factor. Toilets are mostly located outside the sleeping quarters while *achekwu* is no longer a cultural factor amongst the Igala people.

FINDINGS AND DISCUSSIONS

The *Atakpa* the hut located in the courtyard is a major feature in majority of the households studied except for households in the *Egume-Ankpa* community, most of the households in the Ankpa-Egume community were built or rehabilitated for commercial purposes. *The Atakpa* apart from serving the primary purpose of entertainment and receiving of guests, also serves as a focal space linking all individual units within the compounds.

The location and position within the compound of the *Enegbani* and that of the *Unyi-Ubobule* suggests that security and privacy for women determined both locations. The womenfolk are located far from the entrance into the compound while the head of the household is located just beside the entrance into the compound, the *Unyi -Ugwola*, and *Obuka* are also located close to the women quarters to enable easy access and discourage them going far from their accomodations to do their basic functions.

The kitchen was found to be located just by the side of the women's huts: respondent R2, explains "*we keep our foodstuff and ingredients in our room, our kitchens need to be close to that room*". *Aka-the* food barn has virtually disappeared, the foodstuffs are currently stored in the second room of the wives apartment as it was discovered that most wives have more than one sleeping room, the second room serves as a food barn or store for the women.

Apart from the households in Egume-Ankpa road, few of the households in the other three settlements have toilets within the main sleeping and domestic spaces. Table 3 supports this assertion likewise the floor plan sketches obtained. Respondents R3 says "*since the establishment of the university the use of bushes as toilets has greatly diminished, land has become scarce and expensive*". This explains why the households in Ankpa-Egume road have incorporated toilets into the main living spaces.

Most of the households visited in the course of this study used large window and door openings, hence this study shows a decline in the use of small window and door sizes, this phenomenon is caused by the influence of other cultures and modernity as enthused by, Respondent R3 who says "*our children build their houses like the ones in Abuja and Lagos where they work*". This suggests that cultural attributes from other cultures are being infused into the architecture of the Igala people.

The *achekwu* (shrine) was not seen in any of the households studied. The absence of the achekwu is explained by respondent R4 who said: "*Achekwu is no longer fashionable due to religion, people may practice it in private*". It can be inferred that families who still practice this traditional religion have reduced due to the influence of Islam and Christainity. Thus *Achekwu* as a tangible space within the domestic space is not found.

CONCLUSIONS AND RECOMMENDATIONS

This study set out to assess the cultural factors which influence spatial relationships and organizations within households in Igala community, using Anyigba as a case study. The research identified that cultural factors which influence spatial relationships and distributions within the Igala settlements are the need for privacy and security for women, while the *Atakpa (hut)* found in most of the homesteads is centrally located from which all other spaces radiate. Door sizes and Window openings which used to be small have been influenced by external cultural influences making them to be larger in sizes and openings. Thus this research was able to establish that, religion can influence the function as well as extinction of a particular space as in the case of *achekwu* which has disappeared from the households observed.

It is hereby recommended that for the culture of the Igala people to be preserved in its architecture the two cultural factors identified above should be incorporated into new households by built industry professionals, developers and indigenes within the Igala kingdom.

Addendum

Table 4 Profile of Respondents Quoted in this Study.

S/NO	RESPONDENT	PROFILE
01	R1	A 75-year-old farmer. He is the head of his household with primary education two wives and fourteen children. He was interviewed at Aje-Tachi.
02	R2	A 68-year-old trader. She is the first and senior wife of the household a grandmother with no formal education, she has eight children and six grandchildren. She was interviewed at Obeya.
03	R3	A 65-year-old Trader and retired civil servant. He is the head of his household with University education he has one wife and five children. He was interviewed at the Egume-Ankpa road community.
04	R4	A 69-year-old community leader. He is the head of his household with secondary education he has three wives and ten children. He was interviewed at the Iji community.
05	R5	A 50-year driver. He is the head of his household with secondary education he has four wives and twelve children. He was interviewed at the obeya community.
06	R6	A 48-year-old trader. She is the second wife of the household a mother with secondary education, she has two children. She was interviewed at Aje-Tachi.
07	R7	A 38-year-old Motorcycle rider. He is the head of his household with Secondary education he has one wife and three children. He was interviewed at Egume-Ankpa road.
08	R8	A 35-year-old civil servant. He is the head of his household with university education he has one wife and two children. He was interviewed at the Iji community.

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Assessment of Fire Safety Compliance (FSC) in Nigerian Markets: Case Study of Selected Markets in Three (3) Geopolitical Zones

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Abstract

This study assessed the level of fire safety compliance in selected markets within 3goepolitical zones in Nigeria. Questionnaires were administered to traders in some selected markets in Kano, Anambai and Lagos State. Focused group discussions were held with management and associations of the markets as well as officials of state Fire Services. Physical observations were also carried out. 41.69% of the traders interviewed had one form of fire safety knowledge or the other. 3.58% of the respondent had knowledge of fire first aid and rescue. 35.66% had basic knowledge on causes of fire, 30.00% had knowledge of fire prevention, 26.00% had knowledge of controlling fire and 4.75% had knowledge of all the three. 18.75% of the respondents had at least one of fire control equipment however, not maintained. it was also observed that, most markets deviated from the initial layout of the market. Some of the challenges faced by traders that mitigates effective fire management are: irregular water supply, frequent power surges, use of faulty generators due to frequent fire outage, amongst others. This study concludes that there is low level fire safety knowledge in markets as the level of compliance to fire safety measures is also abysmally low. it is hereby recommended that Fire Service should organise periodic enlightenment programmes, conduct Fire Safety Audit in markets yearly. The management of the market should ensure that more fire control equipment is made available and maintained as required.

Keywords: Fire Safety, Compliance, Prevention, Control, Fire Audit.

INTRODUCTION

Fire safety compliance in markets is a nationwide challenge, millions of people have lost their lives and others permanently maimed, properties worth trillions of dollars have being damaged in fire, this has led to serious psychological and economic implications to victims, their relatives and the nation at large. In Nigeria, Fire outbreak in markets has indeed assumed an alarming rate, the spate of these fire disasters is worrisome and has put in the front burner the need to investigate fire safety in markets. Although, there is hardly a national data on fire disaster in Nigeria markets, but available market fire data for few state shows that there were over 500 market fire outbreak from 1999 to date. In 2012, the Federal Fire Service (FFS) attended to a total of 470 reported cases of fires in Lagos and Abuja and properties worth about 6 billion naira was lost, with oil and gas installations as worse hit. However, in 2013, the number of fires increased sharply to 691 reported cases, 31.70% greater than in 2012 with a property loss of about N7.309b. Properties worth about N7 .743b was lost in 569 fires in Lagos and Abuja in 2014, a figure slightly different from 2013 and 6.79% fewer. The results for 2015 shows a reduction of fire cases from 377 to 331, representing 7.97% reduction and a total of N15.7b was lost in the infernos. In 2013, 2014 and 2015, most of the buildings visited by fire are public, residential and market buildings. (FFS Report, 2012 - 2015).

FIRE SAFETY MANAGEMENT (FSM)

Chow (2001) looked at Fire Safety Management as a group of activities, equipment and behaviour designed to both reduce the risk of starting a fire and reduce the risk of injury in the event of a fire which includes:

Provide for safety measures in every building

Ensure that the fire safety measures provided are kept in good order

Initiate actions in case of fire which would help occupant to reach a safe place
Review adequacy of existing fire safety measures where theirs is a change of building, change of building use and new technology on fire service installations
Fire safety management includes four (4) stages, starting from Training, Prevention, Controlling and to Rescue (TPCR). Below is a representation of TCPR of fire safety management.

Fig. 1: Diagrammatic representation of Fire Safety Management

AIM AND OBJECTIVES

This research assesses fire safety management in the markets of three (3) geopolitical zones in Nigeria. This was achieved through;
Appraise the designs adopted in the planning and assess the types of materials used in the construction of these markets.
Determine the level of fire safety knowledge of the traders in the markets.
Determine the level of compliance with fire safety measures by both the traders and management of the markets as stipulated in the Nigeria Fire Safety Code.
Examine problems which militate against effective management of market fires in Nigeria.

SCOPE OF STUDY

This study limits itself to selected markets in three (3) geopolitical zone in Nigeria. North West: Kano State (Abubakar Rimi, Kwari and Kurmi markets), South East: Anambra State (Onitsha Main, Ose-Okwodu and Ochanja markets), South West: (Alaba, Oshodi and Trade Fair Complex markets).

METHODOLOGY

The population of the study was made up of all lock-up shops. Random sampling was used to identify sample areas. Systematic sampling was further employed to select a total of Three Thousand, Two Hundred and Thirty Three (3,233) shops where 3,233 questionnaires were administered. Purposive sampling was again employed to select and interview Federal and State Fire Service, various market Management, Market Associations, who are major stakeholders in the management of domestic fire. A formula was used to determine the sample size. In order to increase the accuracy of the research results, giving room for a minimal degree of error, the research operated at a 95 percent level of confidence with a margin of error of 5 percent. The formula below was used to determine the sample size:

$$n = \frac{N}{1+N(\alpha)2} \quad \text{..... (1)} \qquad \text{Yemane (2016)}$$

Where n= sample size,

N= sampling population; this is the total number of shops in each market.
α= margin of error = 0.05
A sample size of Three Thousand, Three Hundred and Fifty Four (3,233) shops from the selected markets was used.

Table 1: Showing Sample Size

STATE/ LOCATION	Markets									TOTAL
	KANO			ANAMBRA			LAGOS			
	Abubakar Rimi	Kwari	Kurmi	Onitsha Main	Ose-Okwosu	Ochanja	Alaba	Trade Fair Complex	Oshodi	
Number of shops/sampling population	5,300	4,934	2,267	3,990	1,350	1,950	4,000	3,500	3,395	**30,686**
Sample size	380	375	350	370	315	340	370	368	365	**3,233**

Primary data comprised information that was collected using interviews, direct observations and key informant interviews. Focussed Group Discussions were also held with relevant authorities: Federal and State Fire Services, market managements and markets association. Secondary data was obtained from Fire Service, relevant journals, books, internet, statistical bulletin, newspaper report etc. Direct observations also accorded the researchers the opportunity to get first-hand information on compliance with fire safety measures. Data obtained will be analysed using table, percentages and charts.

RESULTS AND DISCUSSION

Market Design and Building Materials used

The design specifications for building of the markets surveyed did not conform to both global best practice and the National Building Code. There is a great disparity between the original designs and the as-built. Many additional structures have been built and alteration works have been carried out which has altered with the designs contributing to challenges in traffic especially in the event of fire emergency. The fire rating of the materials used in the construction of adjoining structures and alterations fall below the stipulations of the National Building Code and National Fire Safety Code, many of these structures are built with softwood wood/timber which has low resistance to fire and contribute to the spread of flame.

Awareness of Fire Safety

Table2. Showing Trader's Awareness of Fire Safety

S/No	State	Markets	Yes		No		Total
			Number	%	Number	%	
1	Kano	AbubakarRimi	283	74.47	97	25.53	380
		Kwari	215	57.33	160	42.67	375
		Kurmi	243	69.43	107	30.57	350
		Total					1,105
2	Anambra	Main Market	198	53.51	172	46.49	370
		Ochanja	195	57.53	145	42.65	340
		Ose-Okwodu	183	58.09	132	41.91	315
		Total					1,025
3	Lagos	Alaba	255	68.92	115	31.08	370
		Trade Fair Complex	217	58.97	151	41.03	368
		Oshodi	213	58.36	152	41.64	365
		Total					1,103
	Grand Total						**3,233**

Table 2 Shows that Rimi market traders in Kano state had the highest (74.47%) awareness of fire safety while traders in Onitsha main market in Anambra state had the lowest (53.51%) awareness. Traders in Kano state had more awareness of fore safety than traders in Lagos and Anambra state. Majority of traders in the markets surveyed had good awareness of fire safety.

Knowledge of Fire Safety

The number of traders interviewed who had atleast one form of fire safety knowledge is 64.25%. Although none of the respondent have knowledge on fire first aid & rescue and 61.88% of the traders have experienced fire outbreak in the markets visited and/or other places and market.

Aspect of Fire Safety Knowledge

Fire prevention is key to fire safety, a good number, 43.00%, of the traders in Lagos have knowledge on the causes of fire, 38.00% of the traders in Kano state have knowledge of fire prevention and 37.00% of the traders in Anambra state are knowledgeable in fire control in all the states visited, less number of the traders are knowledgeable in first aid and rescue in terms of fire.

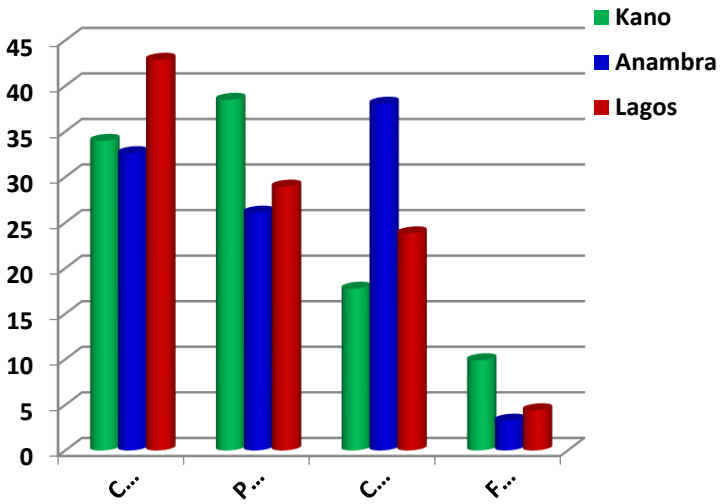


Figure 2. Chart Showing trader's means of Fire Safety

Fire Control

A greater percentage, 38.04%, of the respondents in Anambra state had knowledge of fire control. This signifies that traders are handicap of causes (32.61%) and prevention (26.09) of fire, putting the traders at the risk of fire. Thus, traders fold their hands and wait for fire to start, doing little or nothing to prevent it, before looking for how to control the fire. In Lagos, 23.81% of the respondents had knowledge in fire control while in Kano state only 17.74 % of the traders had knowledge of fire control. Norwich Information Policy Team, 2016 advice that fire risk assessment will help to determine the chances of fire starting and the danger from fire that the premises presents for people who use them.

Control Equipment Owned by Traders

Figure 2.shows that majority of the traders do not have any of fire control equipment. 50%, 53% and 47% of the respondents in Kano, Anambra and Lagos state respectively do not owned fire control equipment. An average of 14% of the traders had a functional fire extinguisher, 19% of the respondents had expired fire extinguisher. 15% believes that soapy water is an alternative fire extinguishing method.

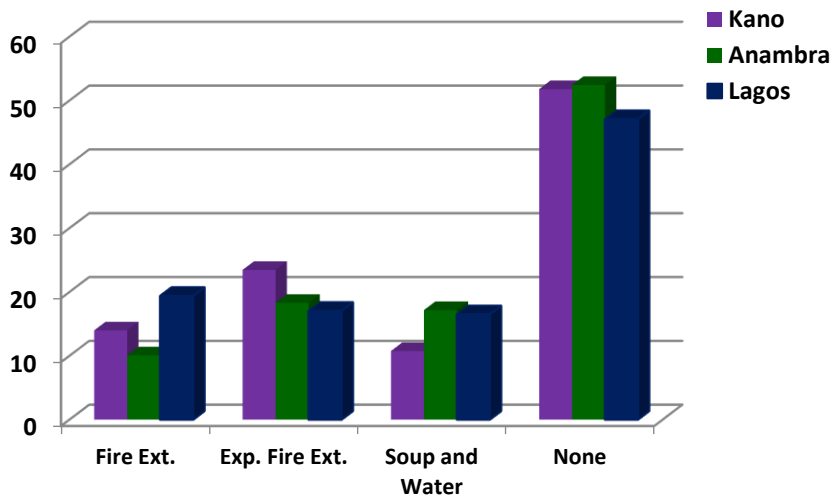


Figure 3. Chart Showing Fire Control Equipment Owned by Traders

Fire Prevention

More of the traders in Kano state had knowledge of fire prevention (38.49%) than causes (33.96%) and control (17.74%) of fire. Although, this high percentage of traders knowledgeable in fire prevention did not translate into practical resulting to the incessant fire outbreak in markets in Kano state.43% of the respondents in Anambra state are of the opinion that not overloading of electrical circuits is the best prevention strategy to fire outbreak. Majority (40%), of the traders in Lagos state believed that the best way to avoid fire outbreak is to avoid careless handling of flammables.

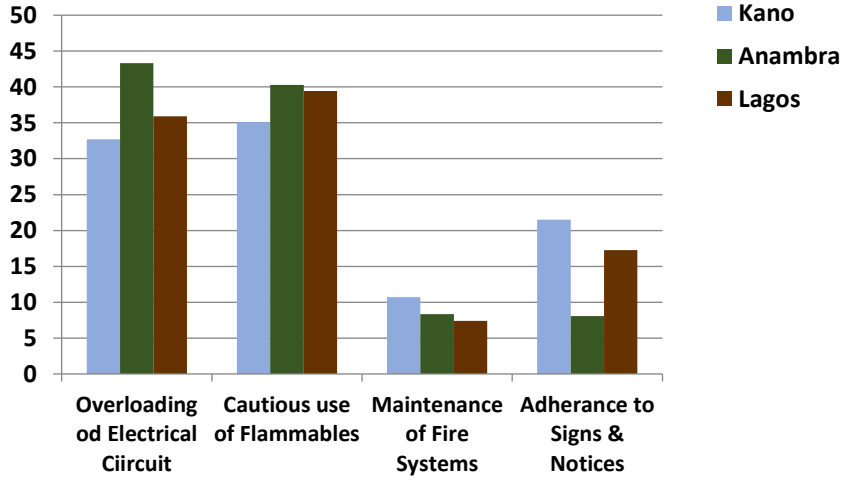


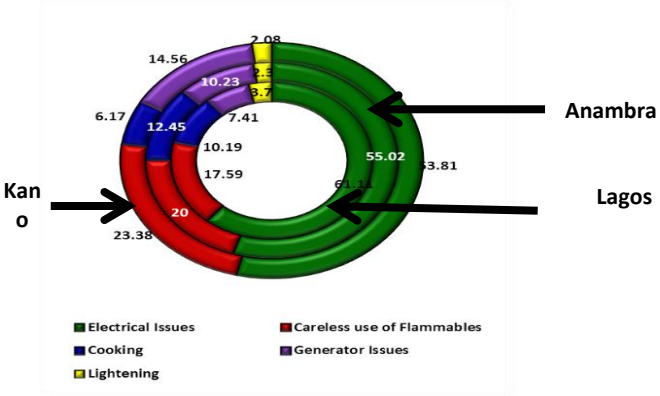
Figure 4. Chart Showing Opinion of Traders on Fire Prevention

Traders in Kano state opined that fire outbreak in markets can be prevented if fire systems and installations are properly and regularly maintained and if emergency signs and notices put in place and traders are educated on them. Generally, traders in all the market surveyed suggested that if users of electrical circuits could avoid overloading them and if traders handle flammables cautiously it would go along way to prevent the and reduce the occurrences of fire disasters in markets.

Causes of Fire

There had been several studies indicating several causes of fire. The chart below shows the perception of respondent with regards to causes of fire.

Majority (42.86%) of the respondents in Lagos state had knowledge of causes of fire than prevention (28.94%) and control (23.81%). This accounts for the recent reduction in fire incidences in the state. Majority, 51.03 %, of the respondents had the opinion that electrical issues are the main cause of fire. However other traders bore their minds on the causes of fire as careless use of candles, careless use of open flames e.g. cooking. 2.43% of the traders believed lightning could also cause fire outbreaks.



Compliance to Fire Safety Measures

Fire Service Outpost

In view of the increasing number of fire outbreaks in the world, the United Nation recommends that every market should have a fire service substation. It was observed that most of the markets visited in the course of this study do not have a fire service station only Abubakar Rimi market and Onitsha main market have fire service station though not fully functiona

Plate 1. Fire Service Outpost in Onitsha Main

Accessibility

It was observed from the markets surveyed that entrance and main streets of some markets complied with Fire Safety regulations which stipulate that, distance between market buildings should not be less than 6m. This is to allow for adequate space for movement of people as well as fire equipment (e.g. Fire truck) in the event of fire emergency.

Plate 2. Entrance of Abubakar Rimi

Plate 3. Distance between Blocks of Kwari Market

Availability of Active Fire Protection Equipment

It was also observed that majority of the markets surveyed had hose reel mostly on the buildings especially on storey building. However, a large number of the hose reels are non functional and in dilapidated state, the usage had also been abused. Inadequate water supply had also hampered the usage of others. None of the markets have a sprinkler system fire alarm and smoke detectors.

Plate 4: Dysfunctional Hose Reel in Markets

Availability of Muster Point

A muster point is an emergency assembly point/area or designated places were all persons using a building assemble in the case of fire emergency. Regulation Reform (Fire Safety) Order RRO, 2005 requires that emergency routes and exist must lead as direct as possible to a place of safety and that procedure for serious and eminent danger must enable the persons concern to immediately proceed to a place of safety in the event of fire emergency. Many of the markets visited do not have muster points, traders run for safety to any place they deem safe. In all the market visited, it was observed that there was total absence of signage's which show direction for safety in case of emergency, smoke detectors were absent and dysfunctional where available. Majority of the markets do not have fire alarm systems.

Problems Faced by Traders in the Management of Fire.

Table 2. Showing Problems Traders Faced in Managing Fire

S/No	Problems	Response (%)					
		Very low	Low	Normal	High	Very high	Weighted average
1	Delays in responding to distress calls by the fire service and other relevant institutions	1.7	7.9	**38.7**	36.4	15.3	3
2	Irregular water supply by Water Board	4.9	5.0	20.5	**45.9**	23.7	4
3	Frequent power surges	5.1	16.1	23.5	4.0	**51.3**	4
4	Indiscriminate use of naked flames and flammables by occupants	20.9	19.1	**22.7**	21.7	15.6	3
5	Generator Issues	16.2	9.3	27.2	**33.5**	13.8	4

The likert in Table 2. Indicates the problems traders are faced with in managing fire and its severity at various degrees. Traders responded very high (51.30%) that frequent power surges and electrical issues is the most challenge trader's encounter in fire safety management. Irregular water supply by Water Board is the second major challenge faced by traders in Fire Safety Management as traders responded highly (45.9%) to this challenge. Frequent power surge was ranked as the most challenging issue in FSM. Indiscriminate use of naked flames and flammables by traders use to be a problem in FSM but due to the effort of FS in sensitization campaigns this problem has reduced to normal. Traders opined that road network

is very significant in managing fire in the market, traders lament highly that poor road network had hampered FSM in the FCT and Nigeria at large.

Problems Faced by Fire Service in the Management of Fire Safety

Number of Fire Service Stations in a State

NPFA standard 1710, establishes an 80 seconds turnout time (time interval at which the emergency call is received and the emergency response unit is notified) and 480 seconds travel time 1.e. 9minutes 20 seconds response time. This can only be achieved if the number of fire service station is adequate and/or the number of staff and equipment is adequate such that they are situated at strategic locations in a metropolitan area with modern communication system. In all the state visited not all the LGA's have Fire Service station or Outpost to say the least, this has led to a response time of 20, 25,30 or sometimes 60 minutes, which is higher than that stipulated by NFPA.

Shortage of Fire Fighters

Shortage of fire fighters poses a serious challenge to fire fighting. The National Fire Prevention Agency (NFPA) USA (2001) noted that inadequate staffing creates a cumulative effect caused by combine delays and loss function of crews, resulting to an even loss of overall effectiveness and increases physiological stress on fire fighters. Some out the Fire Service outpost visited are understaffed which will lead ineffectiveness in combating fire emergency.

Poor Road Network

The road leading to some of the markets in the study area are in a very poor state, making it difficult for FFS fire truck and official to gain physical access to markets in time of emergencies.

False Alarm

False alarm is becoming one of the major problems faced by the FS in managing market fire. People make false call to deceive officers of the FS. According to a report by the FS 65 false alarm was recorded in 2012. In 2013, the number of false calls reduced to 63. 2014 recorded 58 false calls. However, the number of false call attended to by the FS in 2015 was 52.

Water Supply

Officials of FS opined that water supply in some parts of Abuja is irregular, this hinders Fire Safety Management. If the distance to water from the scene of the fire is long this will affect the effectiveness of fire management. Water hydrants are inadequate and located far from markets, the few that are close to or in the market have been destroyed or water supply cut off.

Traffic Grid Lock

Traffic jam was one of the issues identified as a problem militating against effective fire safety management. Increasing rate of car ownership and indiscipline among road users has increase the volume of traffic. This causes delay for the FS officials to get to the scene of the fire in good time.

Some of the key challenges faced by FS in fire safety management are inadequate funding and vehicles for monitoring.

STUDY FINDING AND RECOMMENDATION

Study Findings

Shop spaces are constructed in markets without proper approval from development control boards.

The Fire safety awareness level of traders in the markets surveyed is fair.

There is low level of fire safety knowledge within the traders in the markets. A good number of traders have knowledge of only one of the aspects of fire safety measures.
There is very low level of compliance to fire safety measures by the traders. This is evident from the number of traders that had one or more of fire control equipment.
There is very low level of compliance to fire safety measures by the management of the markets surveyed.
Challenges faced by traders in fire safety management include; delay in responding to distress call by the FS, irregular water supply, and indiscriminate storage of flammables.

Recommendation

Approval should be obtained from relevant town planning body before structures can be constructed in markets and illegal structures should be demolished.
The Fire Service should organize periodic enlightenment programs that would increase the knowledge of Fire safety of the traders, ensure proper enforcement and strict compliance to the National Fire Safety Code in Nigerian market.
The management of markets should ensure that traders in markets comply strictly with fire safety regulations.
Fire safety audit should be conducted periodically in every market.
Development Control and Fire Service should ensure that fire safety measures/design are included in building designs before approval and inspected for compliance after construction.

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Evaluation of Passive Security Measures for Tourism Development in Nigeria

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Abstract:
Security issues continue to raise a threat to tourism development. This has caused several setbacks for tourism development within the country and as such security challenges should be evaluated and resolved as much as possible. The aim of this study is to evaluate security measures for tourism development in Nigeria. The research method employed in this study is the qualitative research method and the process of observation has been employed for gathering data. Observation schedule was used as an instrument for data collection and these data were sampled using the non-random sampling method. These data were analysed through content analysis and the findings showed that security measures have not been properly adopted in tourism development and that most tourism centres have not been optimally developed thereby making them vulnerable to security threats. The research recommends that designing for security should be considered as an utmost importance in the design of tourist centres by professionals and urges the government to look into the development of potential tourist centres within the country.

Keywords: *Passive Security, Planning, Tourism, Development, Tourist centres.*

BACKGROUND OF THE STUDY

Generally, the importance of tourism keeps rising day by day and in its entire ramification that is of significant importance to the economic, social, and environmental well-being of a country. The planning and development system has a vital role to play in realizing the benefits of tourism in any country. According to Yusuff (2015), Nigeria has 7000 tourist centres and tourism is gradually becoming an essential part of the country's economy. The world travel and tourism council (WTTC) in 2014 predicted a growth of 6 per cent annually on tourism in Nigeria. Throughout the world, the tourism industry has been significantly affected by threats of civil unrest, terrorism and instances of terrorist attacks in the modern era. Safety and security are vital to providing quality in tourism. More than any other economic activity, the success or failure of a tourism destination depends on being able to provide a safe and secure environment for visitors (Nwokorie, 2014). Eja (2012) also added that security is of utmost importance in the tourism sector and must be considered as a significant variable. Tourism is an increasingly important source of income, employment and wealth in many countries and its rapid expansion has been considered as an interesting possibility for sustainable development, including poverty reduction, in Nigeria. Tourism is a human activity and can only survive in a peaceful environment. However, the industry faces numerous challenges such as civil unrest, kidnapping for ransom and, recently, terrorism. Terrorism is an issue of a disputed concept which is open to different interpretations regarding motives and causes. However, it can be broadly defined as "premeditated, politically motivated violence against non- combatant targets by sub-national groups or agents, usually intended to influence an audience" (US Department of State, 2004). Notwithstanding, there is a need to proffer solution to this security issues since the benefits and importance of tourism cannot be over emphasized. Thus, the study seeks to examine security measures for tourism development in Nigeria.

Conceptualization of Tourism

Freuler (1905) describe tourism in the modern sense of the world "as a phenomena of modern times based on the increased need for recuperation and change of air, the awakened, and cultivated appreciation of scenic beauty, the pleasure in and the enjoyment of nature and in particularly brought about by the increasing mingling of various nations and classes of human

society, as a result of the development of commerce, industry and trade, and the perfection of the means of transport. Also the World Tourism Organization (WTO) defines tourism as comprising the activities of persons travelling to and staying in places outside their usual environment for not more than one consecutive year for leisure, business and other purposes. The WTO further explains that "Tourism" refers to all activities of visitors including both "tourists (overnight visitors)" and "same-day visitors". These concepts have been adopted based on the study at hand and for a proper understanding of the phenomenon.

Tourism generally over time has proven to be a very strong economic activity that helps to strengthen and boost the economy of nations, by creating lots of job opportunities and providing revenue. In Nigeria, organized tourism can be said to be dated as far back as 1962 with the creation of Nigeria tourist attraction by group of tourism practitioners (Ashikodi, 2010). Much later in the year 1976, tourism was officially seen or considered as a potential economic activity by the government with the establishment of Nigeria Tourism Board (NTB). NTB was replaced by the Nigerian Tourism Development Contribution (NTDC) in 1992. Security challenges in Nigeria have escalated over the years constituting a threat to the industry with foreigners having fears of travelling to Nigeria. Beyond that Nigeria has a limited facility for tourism which in turn poses a considerable risk to tourists.

Passive Security Measures

Skavland and Mejdell (2000) defines security as protection against intended incidents. Desired incidents happen due to a result of deliberate and planned act. The application of security measures or controls is described by Nunes-Vaz, *et al.* (2011) as a physical, psychological, procedural, technical or other device that performs or contributes to one or more security functions. This is achieved through the demarcation/ division of physical space; referred to as zones (Williams, 1981).

Generally, security is classified among prerequisites which continuously undertake leading position when it comes to holidays and travelling. An unsafe or threatened environment usually creates a negative impression of tourist destinations (Richard, 2003). The fluctuation in Nigeria's international tourist receipts is surely as a result of the local security challenges over the years. Meanwhile, changes experienced in the World during the last two decades have been enormous. Security has significantly been compromised due to terrorist acts, local wars, natural disasters, epidemics and pandemics. The travel and tourism industry could not avoid the negative impacts and consequences of these events.

According to Randal (2003), the possible security measures could be discussed around certain terms such as perimeter and exterior security, entry security, interior security, security planning, and crime prevention through environmental design (CPTED). These measures revolved around both passive and active means, covering even the type of plants to be used during design. CPTED is one of the most popular planning strategies for improving safety in cities and large areas or facilities (Jae, 2016). Although the concept of CPTED continues to evolve, basically CPTED is identified by major themes as; natural surveillance, territoriality, access control, activity support and maintenance/image (Moffatt, 1983). Generally, the CPTED principle puts in view the fact that criminals do not wish to be observed and so prioritise over this in form of surveliance such as watch towers, CCTV cameras, and security post. Jae (2016) opined that the safest urban place is one that is continuously watched by humans. Newman (1972) argued that buildings and community designs that encouraged natural surveillance were critical for deterring crime.

Zahner (2017) emphasized that designing for security should be about designing without sacrificing beauty. He explained that this could be done with landscaping art, secondary buildings and disguise barriers. The necessity for security consideration in built environment

is so important that it tells us why we started building in the first place, security is so important in building design and should be considered strictly. Similarly, Bulla (2004) asserts that designing for security is like peeling an onion: it is accomplished layer by layer. Security defences include series of overlapping layers using mechanical and electronic systems, operational procedures, and natural and architectural elements.

The Art Council England (2013) on a practical guide for security stated that the following which have been summarised are security measures that can be fully considered and planned for at the design stage.

a) As the shell of the building is usually regarded as the security perimeter the number of openings should be limited to those necessary for access, ventilation and natural light.
b) Doors, windows and roof lights must all be protected to reduce the risk of large volume loss during the silent hours and have the ability to resist a determined physical attack for as long as the time needed for response forces to attend.
c) The presence of pipes, ledges and buttresses can make windows, roof lights and doors accessible to the intruder.
d) Access/exit can also be made easier through the provision of emergency escape routes that are not secured internally during closed hours or sufficiently protected during open hours
e) Good design can also reduce the possibility of thieves concealing themselves within premises during open hours to break out after closing time. By avoiding unused spaces, dead ends, insecure ducts and panels spaces where someone could hide threats to the collections from theft can be limited.
f) Provision needs to be made for a secure division between the areas which are open or closed to the public with the intruder detection system designed accordingly.
g) Attention paid to the exterior can prevent areas for concealment such as vegetation, porches, deeply recessed doors and adjacent buildings.

From the summarized practical guide on security, major highlights based on passive security measures are building perimeter, openings, accessibility, escape routes, vegetation design, and proper layout design.

According to Crowe (1991), security measures can be well addressed with the adoption or the implementation of the measures provided by the CPTED measures for security. According to Leong (2000), security has been identified as one of the five global forces intended to drive the tourism industry in the new millennium. According to Karam (2015), the important and most widely used measures are related to two dimensions; “Detectors and Access Control”. Access Control as referred by Karam can be refered to as mostly passive means. Over the years the reoccurring issues of robbery, assault, rape, fire, kidnapping, and other incidents have been the concern for tourists. Design and layout, are key passive measures that can be considered in tourist centres.

General Deductions

It can be observed that passive security measures in tourism planning are basically revolving around two broad terms, which are design and layout. After Further looking into these broad terms, certain variables based on the desk study of relevant materials has been deduced. These variables are;

Zoning for Security, Perimetre Fencing, Watch Tower, Landscaping, and Physical/Artful Barriers.

METHODOLOGY

The research method employed by this research is the qualitative research method. A descriptive research design is employed which is a scientific method that can be used in observing and describing the nature of a subject.

The first phase included desk study of relevant materials on tourism development. Thereafter, the research adopted primary source of data collection for the case study stage. This include derivation of first-hand information with data obtained through physical observation. An observation guide was developed by the researcher for the physical observation and extraction of data. This was structured to enable the researcher collect relevant information for analysis. Desk study for the research covers review of relevant literature, reports, journals and manuals by security bodies as well as literary works from experts on passive security. Elements considered in structuring the observation guide were: Zoning, Landscaping, Perimeter fencing, Watch tower, and Physical barriers. These elements were observed across the samples, through both covert and overt observations.

Samples in this research were gotten through convenience non-random sampling technique, which refers to a selection of samples based on targeted interest and subjective judgement. These samples were simply selected for physical case studying based on their relevance to the study at hand, out of a list of known tourist centres in Nigeria. Seven Tourist centres were observed, which were randomly selected across the country. They are; The Obudu Mountain Resort in Cross river state, the Yankari Game Reserve in Bauchi state, the Irin Ijesha Water Fall in Osun State, the Olumo Rock in Ogun State, the Nok Settlement in Kaduna State, the Gurara Water Fall in Niger State, and the Tinapa Resort in Cross River State.

DATA ANALYSIS

Due to the qualitative nature of this research, data gotten have been analysed using qualitative data analysis principles. The data gotten by the researcher using the observation guide was analysed using the Microsoft excel software. Afterwards, the results were presented using plates and figures.

Assessment of Passive Security Design Measures

i. Zoning for Security

The Zoning of site is done in order of privacy, from the parking to residential units. The effective use of zoning laws for security offers a first form defence to the facility. The tourist centres observed showed that four (57%) had a zoning planning to a considerable level as compared to the others as shown in Table 1 and Figure 1 respectively.

Table 1: Zoning design consideration

Names	Present	Absent
Obudu Mountain Resort	✓	
Yankari Game Reserve	✓	
Irin Ijesha Water fall		✓
Olumo Rock	✓	
NOk Settlement		✓
Gurara Water Fall		✓
Tinapa Resort	✓	

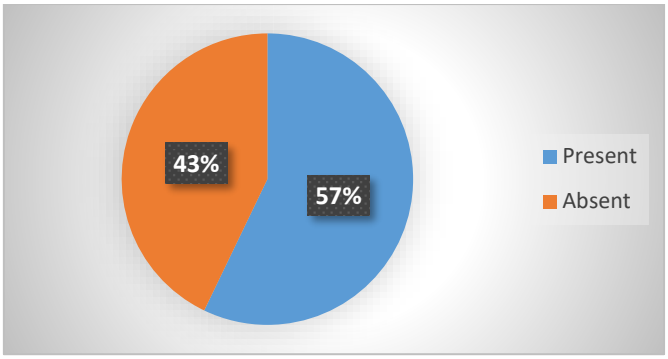

Figure 1: Zoning planning within the observed tourist centres.

ii. Perimeter Fencing

A proper perimeter demarcation goes a long way in showing the first line of defence and giving a keep off warning to passers-by. The tourist centres observed showed that two (2) had site demarcation and five (5) had no site demarcation as shown in Table 2 and Figure 2 respectively.

Table 2: Perimetre Fencing

Names	Fencing	Absent
Obudu Mountain Resort		✓
Yankari Game Reserve	✓	
Irin Ijesha Water fall		✓
Olumo Rock		
NOk Settlement		✓
Gurara Water Fall		✓
Tinapa Resort	✓	

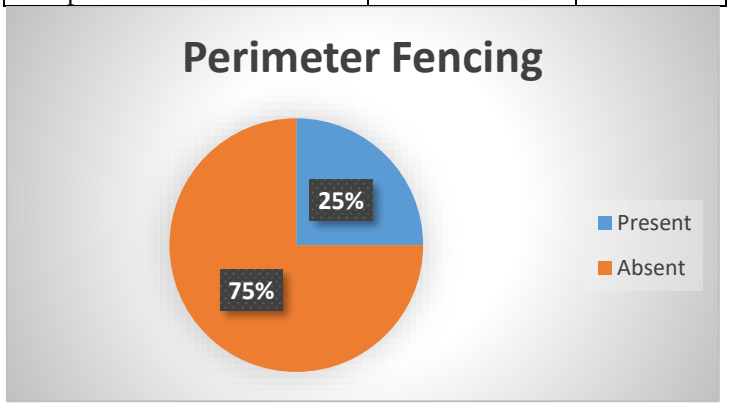

Figure 2: Nature of perimeter fencing within the observed tourist centres.

iii. Availability of Watch Tower for boundary observation

The usage of watch tower as outlined by CPTED is a good passive security measure that can be adopted for general overview in a large gathering or large space. The tourist centre observed showed that the usage of watch towers was not considered in the design as shown in Table 3 and Figure 3 respectively.

Table 3: Availability of watch tower

Names	Present	Absent
Obudu Mountain Resort		✓
Yankari Game Reserve		✓
Irin Ijesha Water fall		✓
Olumo Rock		✓
NOk Settlement		✓
Gurara Water Fall		✓
Tinapa Resort		✓

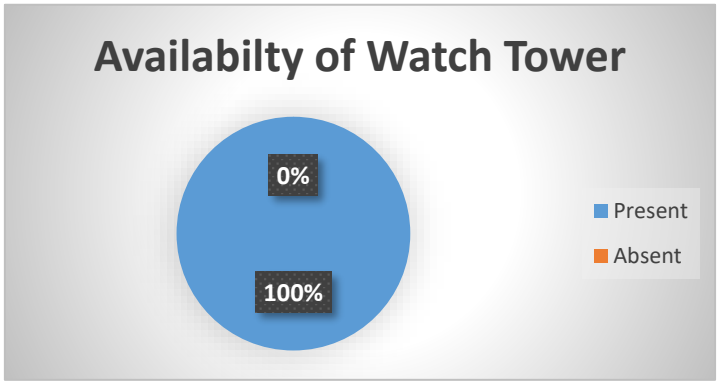

Figure 3: Pie chart showing indication of watch tower within the observed tourist centres.

iv. The Application of Landscape Elements for Security

Landscape elements offer a very interesting passive security measures. The proper usage of landscape goes a long way to provide perimeter demarcation, good sightline, beautiful scenery, channelling movements and good coverage. The use of palm trees has been notably pointed out as ideal plantings hear homes as they have long stems giving a clear sightline and avoiding climbing of branches by thieves into buildings. The tourist centres observed showed that three (3) had a reasonable planning of landscape elements to cater for security, out of seven that was observed as shown in Table 4 and Figure 4 respectively.

Table 4: Use of landscape elements for security

Names	Adequate	Inadequate
Obudu Mountain Resort	✓	
Yankari Game Reserve		✓
Irin Ijesha Water fall		✓
Olumo Rock	✓	
NOk Settlement		✓
Gurara Water Fall		✓
Tinapa Resort	✓	

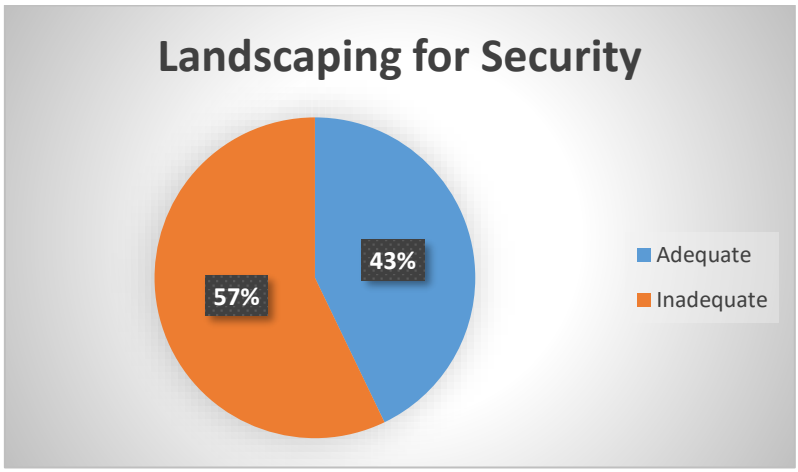

Figure 4: Adequacy of landscape elements planning within the observed tourist centre

v. Physical and Artful Barriers for Access Control

Barriers for channelling movements have gone beyond just mere obstacles to creative and decorative art features that can bring aesthetics to a space. The tourist centres observed showed that there were no much considerations in the use of artful barriers. However, the generic

physical barriers were adopted and their usage across the observed tourist centres is shown in Table 5 and Figure 5 respectively.

Table 5: Use of proper access control features (Barriers)

Names	Adequate	Inadequate
Obudu Mountain Resort	✓	
Yankari Game Reserve	✓	
Irin Ijesha Water fall		✓
Olumo Rock		✓
NOk Settlement	✓	
Gurara Water Fall		✓
Tinapa Resort	✓	

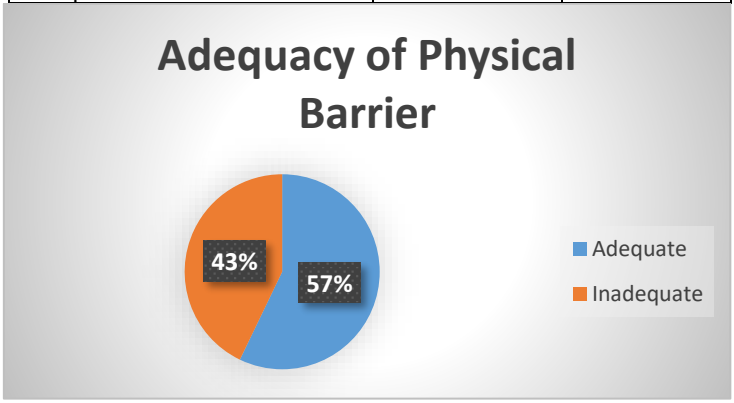

Figure 5: Adequacy of physical barrier planning within the observed tourist centre

FINDINGS

Generally, the analysis shows that security measures are not properly adopted in tourism development. Also, some tourist centres have not been properly developed, which makes them poor in terms of the variables considered and therefore vulnerable to security threats.

The findings show that zoning and physical barrier has a consideration level of nearly 60 per cent which represents the optimal level of consideration.

The design consideration of site boundaries and landscaping for security appears inadequate in most situations.

Watch towers which also is a passive security measure, especially in public areas and tourist centres were observed to be absent.

The implication of these findings is the need to rethink tourist centre designs for passive security measure provisions in order to improve tourism development in Nigeria.

CONCLUSIONS AND RECOMMENDATION

In sum, security challenges must be dealt with for tourism to be developed, and these challenges could be tackled with passive security measures in design. Security measures such as landscaping, perimeter fencing, watch towers and even artful barriers are vital as passive security measures as deduced from the desk study. Meanwhile, tourism in Nigeria generally has not been properly planned with consideration to these security measures and the potentials of most tourist centres have not been harnessed by properly designing for these potential areas. Therefore, this study recommends that professionals in the built industry should take a keen look at designing with respect to security for tourism development within the country and urges the government to look into the development of potential tourist centres within the country.

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Terrain Analysis for Effective Spatial Coverage of FM 92.3Mhz Signal in Minna Metropolis

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Abstract
A Geographic Information System (GIS) viewshed is the result of a function that uses a terrain model to determine which areas on a map can be seen from a given point(s), line or area. A Differential Global Position System (DGPS) was used to acquire coordinates from the field. Geo-referencing and digitization was performed using Arc GIS 9.2 version, which aided the production of Digital map showing the locations of the Radio mast. The optimal sites from where signal have extensive reach and effect, and areas of maximum signal reach were determined using spatial analysis tools in GIS. In this work, measurement of electric field strength of FM radio signals from 92.3MHZ was carried out along streets in Minna Metropolis using a Digital Signal Level Meter, (GE-5499), covering the signal range of 30-120 dBμV, was employed. The Easting, Northings, Altitude (E, N, and H) and also distance from the reference point (i.e., location of the Transmitting Antenna) were measured at every location using a GPS receiver. The parameters obtained were used to map the coverage areas of the Search FM radio signals in Minna Metropolis. It was revealed that FM signal strength and speed are good and fast mainly around the mast, while other areas of considerable long distances have poor or no signal reception (Inverse Square Law). The results also showed that viewpoints on high peaks produce better visibility and signal reception than on lowlands in the line of sight analysis. The study recommends that Radio masts should be installed at locations of high peaks where the line of sight will not be obstructed.

Keywords*: Viewshed Analysis, FM Radio waves, Transmitting Antenna, Signal coverage map.*

INTRODUCTION

Search FM 92.3 Campus Radio is the campus-community Radio of the Federal University of Technology (FUT), Minna. Its information, entertainment and education-driven programmes as well as controlled broadcast -content are meant to capture the attention of the student population and the host community of the University. The campus radio became the harbinger of a liberal and coherent educational broadcast licensing system when the Late President Umaru Musa Yar'adua (GCON) approved and issued a broadcast license to Federal University of Technology, Minna on the recommendation of the National Broadcasting Commission (NBC) on the 4th of March, 2009. It transmits signal in VHF band with a coverage distance between 15km to 29km of radius circle (Theoretical Range). At inception of the radio station, its broadcast was effective in its immediate environment. However, as population grew, expansion increased and Physical development intensified in the immediate environment, many of the newly developed suburbs fell within the black spots of the radio station, coupled with the mountainous nature of the area under investigation.

Radio Frequency Optimization is an important process in verifying and monitoring the performance of any radio network already deployed in an area (Olasunkami, *et. al.*, 2014). It is a periodic activity that is done to maintain a good radio quality of service and enhance end users' perception. Telecommunication signal obeys the law of rectilinear propagation and this needs unobstructed visibility to get to the intended destination with optimal strength. This requires careful network design and planning from site to guarantee inter-visibility and hence communication (Musa, 2009). Global System for Mobile Communication (GSM) and Frequency Modulated (FM) Radio signals can be affected by a number of factors such as: temperature, humidity, pressure, scattering, refraction etc. Atmospheric conditions are favourable at some times and thus pose constant problem to FM network signal. Geographic features such as topography, buildings, mountains and peak with undulating terrain between transmitters and receivers are some of the main barriers to signal propagation (Young-Hoon, et al., 2004)

According to Alenoghena and Emagbetere (2012), the provision of good Radio signal coverage is hinged on the optimal placement of the radio mast; of which a key factor to be considered is the topography of the area. Hence, the need for geospatial techniques to study the topographic related issues affecting signal coverage is the major concern for the decision makers. Therefore, this research sets to check for the effect of the transmission mast height on effective coverage, the effect of topography on Radio transmission mast coverage, and how geospatial techniques can be used to improve the fm signal' coverage within the study area.

Aim and objectives

The aim is to optimize for effective signal coverage of the Search FM92.3mhz campus radio in Minna metropolis through the following objectives;.

1. To determine the spatial location and signal coverage of the transmitting station within Minna metropolis.
2. To conduct a viewshed analysis in order to map out the existing effective signal coverage of the FM radio transmission.
3. To produce an optimized coverage map of the radio signals in the study area.

Justification of the study

One of the major stumbling blocks in this endeavour has been the absence of accurate maps detailing the current signal coverage of search FM92.3MHz, campus radio in Minna metropolis. Hence, this work demonstrated how a precise map of signal coverage was accomplished and provide helpful information to the information services for wireless management in the campus, which was lacking prior to this research. (Bakare, 2019; Nigatu , and Biadgilgn ,2017).

The Study Area

The search FM 92.3 Mhz is at Gidan-Kwano Campus of FUT Minna, located along Minna – Bida Road, in Bosso Local Government Area of Niger State, Nigeria. The Campus is located at 09^0 32' 30.46"N, $06^0$26'14.37"E at the top left, 09^0 31'15.84"N, $06^0$27' 20."67E at the bottom of the longitude and latitude respectively

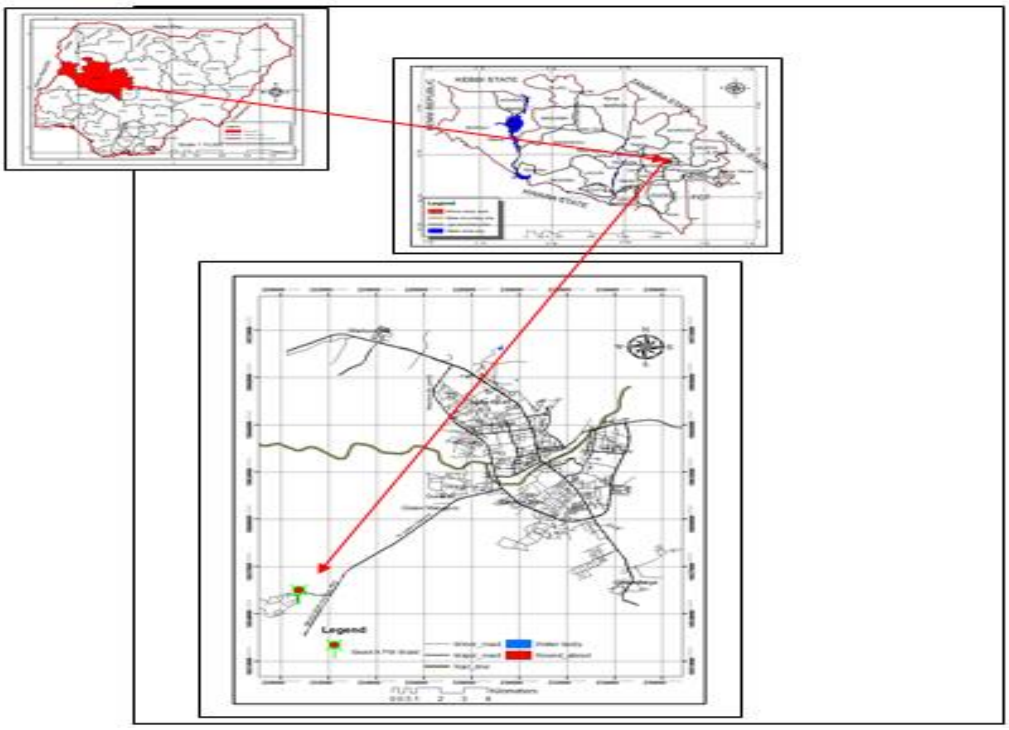


Figure 1: The study area

MATERIALS AND METHODS

Using ESRI's ArcGIS 9.10 version and other relevant GIS Packages in conjunction with a generated DEM of the study area, satellite image of the area was draped on the DEM to give a 3D view of the area. The generated (ASTER DEM was exported to ArcGIS where viewshed analysis was performed. Viewshed analysis was run based on the location of the existing radio mast/tower (FM 92.3MHZ) and on a digitally proposed new location (219144.00E, 1062460.00N) for effective coverage and to determine the line of sight (areas in view / not inview) along the major routes within the study area (Minna Metropolis)

Data:

Table 1: Data Used

S/N	Data Type	Scale	Source
1	Quick bird image 2017 10m spatial resoluton	10m resolution	From Image GeoEye.(Google Image)
2.	ASTER DEM 30m spatial resoluton	30m resolution	www.Earthexplorer.usgs.gov.
3.	GPS coordinates of Transmitting Radio masts& locations with their signal strengths(strength meter readings)	0.005m resolution	Author's fieldwork, 2017
4	Contour Map of Minna Metropolis Derived from ASTER DEM.	1:125000	WWW.Earthexplorer.usgs.gov.
5	Map of Minna Metropolis,(Street Guide map)	1:10000	From Surveying and Geoinformatics Department, FUTMINNA.

Table 2: Parameter of Search FM 92.3MHZ

Altitude	Frequency	Easting(m)	Northing(m)	Transmitter output power FM92.3MHz	Mast Height above ground level
243m (msl)	92.3 MHz	220750 .00E	1055227.00N	44-46Volts	52m

Source: Field survey, 2017.

Note: MSL = Mean Sea Level; MHz= Mega Hetz.s

Therefore, this paper tends to provide solutions to alleviate the geographical barrier by incorporating Geographic Information System technologies with respect to the spatial coverage of radio waves.

Methods

The desire to meet the communication needs of increased number of listeners in the suburbs; complaint of signal loss; difficulty in signal reception; limitations due to transmission power, tower height and antenna gain, interferences, deserves special attention in improving the radio wave coverage for optimal transmission.

The field work involves measuring the Eastings and Northings coordinates of the transmission station and several points of interest; the elevation above sea level; the line of sight distance between points of interest and the transmitter base using GPS; and the field strength of the radio signal. The electric field strength of the transmitted FM signal of all the points of interest with their corresponding distances (LOS) from the base station were measured. The data so collected were tabulated for easy computation / analysis and used to plot the contour map of

the coverage area using surfer 8 with coordinates (Eastings, Northings, Signal strength). The procedure was repeated in all the Drive routes in Minna Metropolis.

Spatial location of Transmitting Station (Search FM92.3MHz)
Using the coordinate of the existing mast, Transmitter A (220750.00E, 1055227.00N), a point shapefile was created.

Viewshed Analysis
Two viewports were used (FM92.3 Radio transmitter and a new proposed site) to measure signal coverage along some selected routes in the study area. Viewshed analysis was done twice. Firstly, the analysis was done to identify areas in view/not in view based on the present location of the transmitter and secondly, another one was done after digitally shifting the transmitting station to a presumed better location based on the intervening topography and visibility analysis (Thomas and Shelley 2008; Musa, 2009; Edan et al, 2013) A viewshed map was produced depicting the radio signal coverage for the study area; Minna Metropolis.

DISCUSSION OF RESULTS AND FINDINGS
This section presents the results, interpretations and discussion of results based on the analysis carried out. The descriptive measures were used to describe the characteristics of the sample based on the method used in gathering the field data. Below is the ASTER DEM generated depicting the spatial location of Search FM92.3MHZ and the proposed new site of the radio Transmitter.

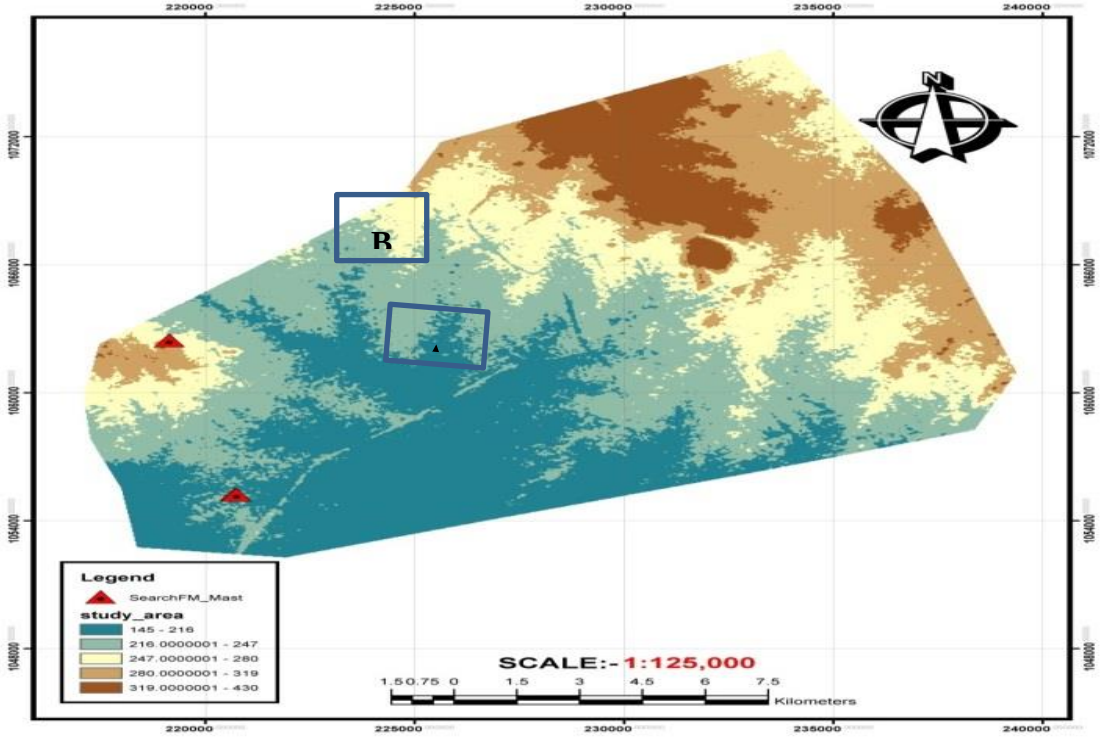
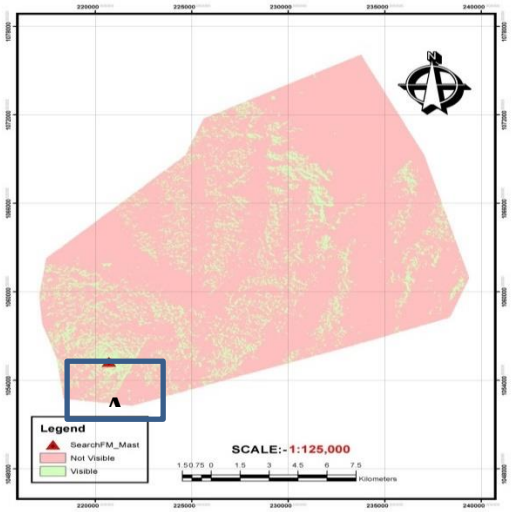


Figure2: Spatial location of the existing structure of Search FM92.3mhz (A on the map) and the new digitally proposed radio mast position (indicated as B on the map).

Viewshed Analysis for effective Radio signal coverage of Search FM in Minna Metropolis.
Find below the results of optimization carried out using the Geospatial tools (veiwshed analysis) of the fm radio transmitting station in Minna Metropolis.



B

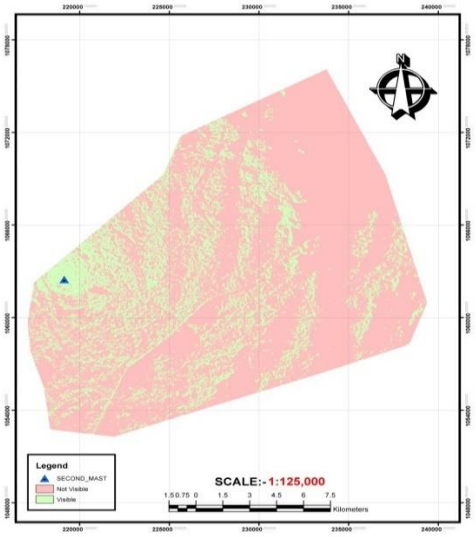


Figure 3 (A) Figure 3 (B)

Figure 3A&3B: Viewshed map of existing radio mast at a height of 52m (Left) and the proposed radio mast at a height of 80m (Right).

Table 3: Optimized coverage of the campus radio (Search FM92.3MHz), covering Minna Metropolis, Niger State.

Location	Eastings (m)	Northings (m)	Mast Height (m)	Viewshed Analysis; Visible Areas(Hectares)	Viewshed Analysis; Not Visible Areas(Hectares)	Remarks
A (Existing Mast)	220750.00	1055227.00	52	4079.504Ha	28820.29615Ha	Fair coverage (12%)
A (Existing Mast)	220750.00	1055227.00	80m(Proposed)	6421.945674Ha	26477.85433Ha	Fair coverage (20%)
B (New proposed Mast)	219144.00	1062460.00	52m(Proposed)	6002.88563Ha	26896.91437Ha	Fair coverage (18%)
B (New proposed Mast)	219144.00	1062460.00	80m(Proposed)	7158.512913Ha	24741.28709Ha	Good coverage (22%)

Spatial Location/ Coverage of Search FM92.3MHZ (Contour Map of Radio signal coverage)

To determine the effective radio signal penetration and coverage a contour Signal map of Search FM (92.3 MHz), Campus Radio, was overlaid on the DTM map of Minna Metropolis to determine areas that receive signals from the FM radio station, as shown below;

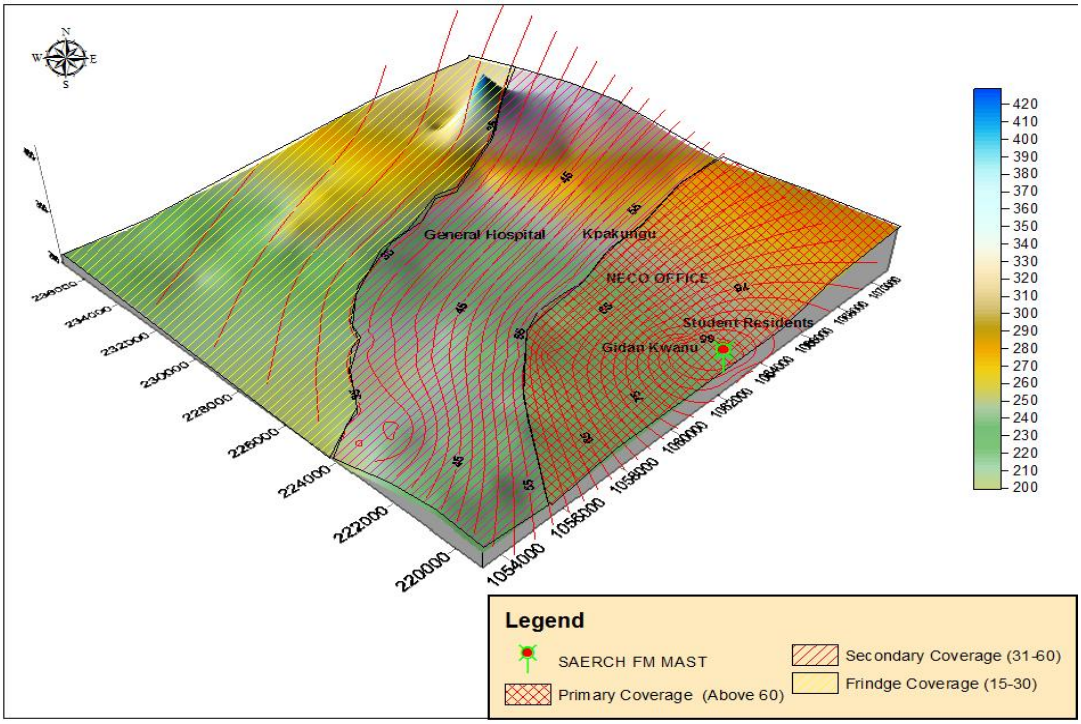


Fig 4: Signal Coverage Map of Search FM in Minna Metropolis

Coverage classification

Table 4: Coverage Classification (%) within Minna metropolis

	Area(Hectares)	Percentage (%)
Primary Coverage Area (40dBµV≤/E/≤82dBµV)	8800Ha	23%
Secondary Coverage Area (20dBµV≤/E/≤39dBµV)	20,100Ha	51%
Fringe Coverage Areas (15dBµV≤/E/≤19dBµV)	10,200Ha	26%
Total	39,100Ha	100%

The configuration of the Search FM92.3mhz radio transmitter in Minna Metropolis does not give optimum coverage in the Study area. It was observed from Figure 4 above, that 23% of of the investigated coverage area being 8800Ha received primary coverage, while 51% of 20100Ha received secondary signal coverage and 26% of 10200Ha was categorized on fringe coverage out of the total Area of 39100Ha (See table 4 above). This implies that grade "**A**" signal applies to locations close to the transmitting station which obeys the inverse square law of signal propagations.

However, in Bosso campus, secondary coverage was experienced and interference from Prestige FM 91.7MHz, due to its proximity to Bosso campus. The DTM of the Study area depicts a hill (Maitunbi hills) as an obstruction to rectilinear propagation of the radio signal. This blockage resulted into non line of sight propagation (NLOS) causing multipath, diffractions, reflections and non-coherence propagation.

CONCLUSION AND RECOMMENDATIONS

Conclusion

This study reveals the spatial coverage of the campus radio (Search FM92.3mhz) transmitter in Minna Metropolis, limited by some geographic features such as hills, mountains, buildings, vegetation cover, valleys, rivers etc. This study reveals the spatial coverage of the campus radio transmitter in Minna Metropolis is affected by the topography.

Recommendations

Based on this study, it is recommended that:

1. The study recommends that Viewshed analysis should be used as a tool for the determination of optimal site and outreach for other telecommunication networks such as Airtel, Glo, MTN, TV, and radio stations.

2 At the FM frequencies, the radio waves follow line-of-sight propagation, which is rectilinear. Therefore, increasing the height of the radio tower from 52m to 80m will also improve the signal coverage in its current region by raising it further above trees, buildings or hills that may cause obstruction with the signal. This will enhance the current signal's region and also increase the maximum distance of the signal coverage in the metropolis

3. Mast should be installed at locations (B) where unobstructed line of sight exists between optimal sites and visible boundaries of the study area to increase signal coverage. However, location B (219144.00E, 1062460.00N**)** which was digitally determined at a distance of 2.973km with a bearing of 347º 28' 52'' away from the existing tower proves to provide feasible improvement for effective signal coverage of search FM campus radio as it has been presented in this study.

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Effect of Urban Land-Use Planning Regulations on Residential Property Investment Returns: Evidence From Literature

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Abstract:
Different socio-economic activities in the urban areas take place on land, a unit whose relationships and significance is guided by policies. Literature have clearly shown that urban land use planning and management policies and regulations influence residential price due to its latitudinal bond with locational, structural and neighbourhood attributes in the housing market. This paper reviewed related literature and observed that the trends in studies on the effect of urban land use planning regulations on residential property investment returns have been advancing in continents like Asia, America, Australia and Europe but lagging behind in African countries like Nigeria. It was found that computable but varied price premium were paid for housing attributes such as bedrooms, greenbelt land and proximity to school by buyers/renters for residential properties. Hence, this variables are significant predictors of housing price/rent. This paper recommends that these variables should be considered in urban studies of developing countries like Nigeria with a history of ineffective urban land use planning and management policy to unearth the peculiarities of their urban regions.

Keywords*: Urban, Land-use, Regulations, Residential property, Returns.*

1 INTRODUCTION

Countries often engage in active land use planning by imposing restriction. Arguably, to guarantee investment decision. Jha et al. (2010) observed that urban land use planning regulations (ULUPRs) is a communal policy exercise that defines and controls the use of a particular land in order to enhance the economic, physical, social efficiency and safety of a people in a geographical location. Every geographical area have unique ULUPRs. Indeed, it is pervasive and fundamentally determine the form of a city, physical development pattern and occupancy, transport and cost of housing (Lovkovich et al., 2018). Hence, ULUPRs could affect rent/housing price directly, through a particular use permitted in the neighbourhood or indirectly by creating a residential neighbourhoods and cities of certain feature (Kok et al., 2014), this influence are observed in form of local amenities or disamenities and significantly shape the extrinsic and intrinsic attributes of housing in price definition (Rahadi et al., 2013).
Interestingly, economists have observed that ULUPRs affect residential property in three specific ways: amenity effects, restrictive effects and scarcity effects, these effects are part of the driving forces in urban property market (Jeager, 2007). In addition, Monkkenon (2013) is of the opinion that places where ULUPRs are not stringent, their influence on the housing markets are not clear. Hence, requires empirical study. The effect of ULUPRs on housing have a latitudinal bond within the property market in terms of its location, structural and neighbourhood attributes that determine housing price. Obviously, these attributes have been utilized in hedonic models globally and have advanced significantly over the years.
Housing price/rent is a reflection of the intrinsic and extrinsic attributes of a property, as a result price is arrived at through a series of negotiation by parties involved. Effective demand can only be attained if the buyer/renter is willing to pay (McDonald and McMillen, 2007). Most at time buyers rely on a lot of features before they offer their bid and among them are the triple attributes which play a significant role in influencing the decision of the buyer/renter. Understanding renter and/or buyers housing welfare and the performances of the property

market in urban centre in this context is of crucial concern to the real estate developers, investors, urban planners, policy makers, economists and researchers.

At the same time, there are limited academic literature (see table 1) on developing countries studying the relationship between various attributes of ULUPRs and residential property investment returns (RPIRs), although widespread in the existing literatures of property value models of developed Nations (Michael and Palmquist, 2010; Gyourko and Molloy, 2014). This review unearth persistent housing attributes used in literatures to study ULUPRs and RPIRs. The rest part of the review is structured as follows. Section 2 attempt an overview of the global literature from 2007-2019 and classification of housing attributes that have been utilized in hedonic models/theory. Section 3 present empirical literature on the effect of ULUPRs on RPIRs whilst in section 4 Conclusions.

2 FUNCTIONING OF HOUSING ATTRIBUTE IN URBAN AREAS AND HEDONIC PRICE MODEL

Literature utilized in this study suggest that researchers utilised Rosen (1974) hedonic price theory/model to understand and explain the relationship between components of housing attributes and housing price/rent. The theory provide an insight into relationship between price/rental trends and output of housing as a product. In the housing price model the renter/buyer relate the worth of real estate to its various tangible attributes thus obtaining their minimal contribution or the hedonic price. Consequently, the rent or selling price is the exogenous variable. Endogenous variable describe the property intrinsic and extrinsic features, this include among others nearness to commercial centre, number of rooms, and lots size of the property.

From available literature less attention have been given to reviewing housing attributes that are commonly used in studying ULUPRs and housing prices/rent. Ajibola et al. (2012); Michael and Palmquist (2010) suggested frequent usage of location, structural and neighbourhoods regulations attributes in hedonic price model because they are the fundamental determinant of housing price/rent. Hence, it is pertinent to uncover in this review the attributes that are in use consistently in studies of ULUPRs and housing value. This will specifically guide future studies on choice of variables particularly in developing economies where there are dearth of empirical studies; and have a history of ineffective land use policy and management (Awuah et al. 2014). Table 1 below, shows 33 articles from reputable journals which were reviewed between 2007- 2019. The table suggested that there is no general concise on the sample size to adopt, hence the sample size may have been determine based on analytical tool used and population of study because 84.85% of studies employed sample size that ranges from 42 to 9027 while 15.15% adopted above 10000. Also 96.97 % of the studies adopted quantitative research approach and utilized regression signifying that this methodology is universally acclaimed for a research of this nature. Hence should be utilised in subsequent studies.

Subsequently, 30 structural regulations attributes were identified to have been utilised in hedonic price studies globally from 2007 to 2019. Table 2 below present existent structural attributes and the number of time each occurred. Most occurring structural regulations attributes include: Plot size, age of a house, floor to area ratio; averagely occurring are number of bedrooms, number of bathrooms and number of lot tree; whilst fairly occurring are garage, water source, floor level, material for roof, living area, finished area of the house, property right and level of services. The cumulative incidence of manifestation of these structural attributes account for about 80% of the structural variables utilized in hedonic studies. This indicates that the outcome of the most occurring, averagely and fairly occurring structural attributes unearth, are likely to be strong predictors of RPIRs which could either be positively (amenity effect) or negatively (disamenity effect).

As a result, it is suggested that depending on the various ULUPRs used across a geographical area, the choice of structural regulations attributes to be incorporated in future hedonic studies can include these 14 structural variables. For instance variable such as numbers of trees in cold

and polar region might not be of significance as such will not be pertinent for incorporation in the price model though in dry, tropical and temperate region it will assumes a significant role

Table 1: Overview of empirical studies

S/No	Study	Study area/Continent	Sample size	Methodology
1	Ihlanfeldt (2007)	Tallahassee/ N.America	136,158	Quantitative/Regression
2	Jeagar (2007)	Oregon/ N. America	1993	Quantitative/Diff-in-diff
3	Yusuf and Resosudarm (2009)	Jakarta /Asia	470	Quantitative/Regression
4	Tang and Yiu (2010)	Hong Kong/ Asia	378	Quantitative/Regression
5	Donovan and Burty (2011)	Oregon / N. America	985	Quantitative/Regression
6	Huang and Tang (2012)	USA	327	Quantitative/Regression
7	Jeagar *et al.* (2012)	Oregon /N. American	1993	Quantitative/Diff-in-diff.
8	Ajibola *et al.* (2012)	Lagos/Africa	260	Quantitative/Regression
9	Monkkenon (2013)	Indonesian/Asia	42	Content analysis
10	Boamah (2013)	Ghana/Africa	741	Quantitative/Regression
11	Bello and Yacin (2014)	Maiduguri/ Africa	372	Quantitative/Regression
12	Awuah *et al.* (2014)	Ghana/Africa	45	Quantitative/Regression
13	Kok *et al.* (2014)	San Francisco/USA	7358	Quantitative/Regression
14	Wen *et al.* (2014)	Hangzhou/Asia	649	Quantitative/Regression
15	Turner *et al.* (2014)	USA/North America	2729	Quantitative/Regression
16	Boyle *et al.* (2014)	Florida/ N. America	3500	Quantitative/Regression
17	Du and Zhang (2015)	China/ Asia	410	Quantitative/Regression
18	Wen et al. (2015)	Hangzhou/Asia	2887	Quantitative/Regression
19	Zou, (2015)	China/Asia	2160	Quantitative/Regression
20	Lima and Neto (2015)	Brazil/S. America	5498	Quantitative/Regression
21	Jackson (2017)	California/ America	420	Quantitative/Regression
22	Guo *et al.* (2017)	Adelaide/Australia	2700	Quantitative/Regression
23	Lai *et al.* (2017)	Shenzhen/Asia	120	Quantitative/Regression
24	Brueckner et al. (2017)	China/Asia	2589	Quantitative/Regression
25	Wen *et al*. (2017)	Hangzhou/Asia	660	Quantitative/Regression
26	Levkovich *et al.* (2018)	Netherlands/Europe	71578	Quantitative/Regression
27	Brueckner and Singh (2018)	Washington/N. America	9027	Quantitative/Regression
28	Severen and Plantinga (2018)	California/ N. America	10794	Quantitative/Regression
29	Greenaway et al. (2018)	New Zealand/Europe	1984	Quantitative/Regression
30	Li *et al*. (2018)	China/ Asia	47,790	Quantitative/Regression
31	Kim *et al.* (2019)	Korea/Asia	11,498	Quantitative/Regression
32	Jeon (2019)	Korea/Asia	1040	Quantitative/Regression
33	Tan *et al.* (2019)	Wuhan/Asia	7090	Quantitative/Regression

The importance of neighbourhood regulations attributes in hedonic price studies cannot be overemphasised in urban studies. The distinct variables of these groups of housing attributes employed in hedonic price model is therefore a concern. Table 3 presents the attributes used to describe neighbourhood subset of the hedonic price models in empirical literature.

Sequel to the review of 33 empirical literature, 15 neighbourhood regulations variables were also discovered to be used in hedonic price models. These variables were described in various range of attributes as each of the empirical literatures contextualize the variable to suit the respective studies' operationalization. Hence, might not be realistic to have a common ground categorization of the attributes that are habitually utilised in hedonic price model in literature studying housing rent/price and ULUPRs in urban studies. This is in line with the view of Laerdal and Vorkinn (2017) that environmental conditions and relative importance placed on neighbourhood and location attributes may sway their choice to be included in a given hedonic price model of a given case study.

Table 2: Occurrence of structural variable in the empirical studies

S/no	Structural variable	Numbers of. variable appearance
	Variables that occurs most	
1	Lot size /Plot size	14
2	Age of house based year	17
3	Floor to area ratio (density of development)	11
	Variables that occurs 6 to 10 times	
4	Number bedrooms	10
5	Number of bathrooms	7
6	Floor level	7
7	Numbers of lot trees	6
	Variables that occurs 4 to 5 times	
8	Living area	5
9	Finished area of the house (size of the house)	5
10	Property right (C of O)	5
11	Garage	4
12	Water source inside (pipe)	4
13	Material for roof	4
14	Level of facilities/service	4
	Variables that occurs 2 times	
15	Building permit	2
16	Property management	2
17	Material for floor	2
18	Construction materials	2
19	Type of heating	2
20	Type of fire place	2
21	orientation	2
	Variables that occurs once	
22	Air conditioning	1
23	Architectural design	1
24	Family size	1
25	Use change permit	1
26	Lightening condition (orientation)	1
27	Ventilation	1
28	Outside wall material	1
29	Liquid waste disposal	1
30	Solid waste disposal	1

Table 3: Attributes defining neighbourhood in the reviewed empirical studies

Type of attributes	Attributes	References
neighbourhood	Distance to nearest school	Yusuf and Resosudarmo(2008); Awuah et al. (2013); Monkkenon (2013); Wen et al. (2015); Guo et al. (2015);Wen et al. (2017); and Brueckner et al. (2017) Li et al. (2018) and Tan,(2019)
	zoning	Ihlanfeldt (2007); Jeager et al. (2012); Monkkenon (2013); Jackson et al.(2016)
	Electricity	Awuah et al. (2013); Monkkenon (2013); Bello and Yacin (2014) and Lima and Neto (2015)
	Distance to arterial road	Guo et al. (2015); Brueckner et al. (2017); and Yusuf and Resosudarmo (2009) and Tan (2019)
	Paved street	Awuah et al. (2013); Wen et al. (2014) and Monkkenon (2013)
	Sport facilities	Tang and Yiu (2010); Wen et al. (2015) and Wen et al. (2017)
	Property management	Wen et al. (2015) and Wen et al. (2017) and Li et al. (2018)
	Drainage system	Awuah et al. (2013)and Monkkenon (2013)
	sewerage	Monkkenon (2013) and Lima and Neto (2015);
	Surrounding facilities	Boyle et al. (2014); Wen et al. (2017); and Li et al. (2018)
	Neighbourhood planning	Ajibola et al. (2013) and Monkkenon (2013)
	traffic	Yusuf and Resosudarmo (2009) and Wen et al. (2014)
	Street lightening	Monkkenon (2013)
	Telephone line	Awuah et al. (2013)
	Security	Donovan and Burty (2011)

Table 4 also, shows the attributes commonly used to describe location subclass of the hedonic price models as utilised in empirical literature. After the review, 13 location variables were found to be used in hedonic price models.

Table 4: Attributes describing location used in hedonic price models in the reviewed studies

Type of attributes	Attributes	References
Location	Distance to park	Donovan and Burty (2011); Awuah et al. (2013); Kok et al. (2014); Zhang et al. (2014); Guo et al. (2015); Brueckner et al. (2017) Li et al. (2018); Kim et al. (2019) and Tan (2019)
	Distance to city centre	Ihlanfeldt (2007); Yusuf and Resosudarmo (2009); Tang and Yiu (2010); Donovan and Burty (2011); Kok et al. (2014););Li et al. (2018);Kim et al. (2019) and Tan (2019)
	Distance to subway station and bus stop	Tang and Yiu (2010); Levkovichet al. (2018); Li et al. (2018); Kim et al. (2019) and Tan (2019)
	Number of street trees	Donovan and Burty (2011); Bello and Yacin (2014).
	Distance to garbage dump, police station, and slum.	Monkkonen (2013)
	Distance to earthquake fault line and work place	Kok et al. (2014)
	Distance to hospital	Li et al. (2018)

3. Effect of urban land use planning regulations on residential property values

In the developed world there has been consistency in studies on different features of ULUPRs on property values. After the review, three group of studies in the hedonic price model across the urban areas were unveiled.

First subset focused on using model to quantitatively evaluate the amenity and disamenity effect of ULUPRs on housing price (capital value). These Studies were led by Pogodzinski and Sass (1990); Ihlanfelt (2007) and Tan (2019) that ULUPRs restrictive measures raise house premium price. While some of the studies centred on predicting the future economic benefit and cost derivable, others concentrated on the immediate pecuniary benefit accruing as a result of ULUPRs. While other benefits may not be pecuniary (Awuah et al. 2014).

Li et al. (2018) in their study in Shanghai observed that 1% increase in floor area and 1% increase in number of metro-station has a corresponding 0.05% to 0.08% and 0.03-0.04 % of housing price premium respectively. This is in contrast with finding of Brueckner and Singh (2018) from cities in United State and Guangzhou that number of bedrooms is not significantly positive to housing price premium due to averse nature of buyers for an additional bedroom.

Also, Lai et al. (2017) in a study of 120 property in Shenzhen found a 62% difference between property with full property right housing and those without. Recently, Jeon (2019) in a study in Korea unveil that land under zoning have 76.5% house price premium as compared to others. Also, Jackson (2017) observed in California using data from California land use regulatory index that increase in regulation is proportional to 5% house price premium indicating a positive correlation. While, Wen et al. (2014) observed in China that the presence of a school within 1 km from the community improve housing price premium by 0.300 %, whereas houses situated less than 1 km from school enjoy price premium by 2.737% or 0.904%. This unveil the significance of laws on education facility in the residential market.

More so, study by Tan (2019) have shown that metro station increase average price premium of a home within 400m by 26.6% than homes further away in Wuhan, this buttress the need to adhere to regulations for establishment of neighbourhood facility. On the contrary, Du and Zhang (2015) in a study in China observed that home purchase restriction law decrease housing price by 7.69 %. Monkkenon (2013) also unearthed in his study in Indonesian that restrictive measure decrease house price because of flexibility in enforcement and the proliferation of informal housing sector.

Second subset look at ULUPRs in terms of its effect on rent levels (rental income). Donovan and Burty (2011) discovered an additional tree in lots increase rent by $5.62 and also on public right of way by $21 in Oregon. Also, Lima and Neto (2015) also document through intercity analysis and matching method an increment of 5.4 to 6.3% premium rent as a result of zoning in Brazil. In a later paper, Jeon (2019) in his study of 120 properties in Korea discovered that neighbourhoods with urban growth boundary regulations (zoning, greenbelt land) have 60.1% price premium rent compared to others.

Final subset look at price elasticity of housing supply. Grimes and Mitchel (2015) in a study in Auckland observed that 90% of developer decision are affected by stringency of building height restrictive regulations, balcony requirements, minimum floor to ceiling height and conforming to Council's desired mix of apartment typologies thus causing delay and uncertainty to housing production at the long run. Huang and Tang (2012) analysed data of 300 cities in US and demonstrated that cities with stringent ULUPRs experience housing price premium between 2000-2006 and greater price decline between 2006-2009 owing to land supply constraint laws. On the other hand, Jackson (2016) discovered that an addition of zoning and general control regulation reduce residential permit by 4% explaining the reduction in single and multiple family permits.

This phenomenon of volatility in housing price/rent and elasticity of housing supply could be explained by Dempsey et al. (2016) in their study in the United State, that stringency rules are implemented at different levels across municipalities with diverse demographic and socio-economic structures. In other words, the magnitude of the effect of ULUPRs will vary with the social system and background of each geographical region, hence contextualization of hedonic studies. For example, countries in Sub-Saharan Africa have record of ineffective land use planning and management (Awuah and Hammond, 2014). There is therefore the need to unearth their peculiarity in urban studies for lessons to be drawn.

From this study, majority of findings indicated that substantial price premium are paid by buyers of residential interest in form of rental/ capital income owning to ULUPRs which shape the structural, location or neighbourhood attributes of housing. This insight is from the purview of buyers of residential attributes. It is only natural to agree that having an insight to the effect of housing attributes on the performance of residential real estate (return on investment and capital appreciation) will assist to understand housing returns dynamic at a time when global emphasis is on investment returns Nwankwo et al. (2018); Nassi et al. (2019) instead of emphasising on rental/capital value that cannot be equated to stocks and bank shares. Understanding the utility derivable by renters and buyers of residential properties in urban centres particularly of developing countries where there is dearth of such studies in addition to ineffective land use policy and management will be opportunities for further studies on housing investment performance/returns.

CONCLUSIONS

The reviewed literature have shown the commonly employed structural attributes of housing in hedonic price studies in the urban property market from 2007-2019. These attributes include plot size, age of house, floor to area ratio, numbers of bedrooms, numbers of bathrooms, floor levels, numbers of trees, Living area, size of the house, property right, presence of garage, water source, material for roof and level of facilities. This structural variables are suggested as vital for inclusion in property hedonic price model.

Also, we discovered that every geographical study contextualised the location and neighbourhood regulations attributes. Therefore, based on this literature review the following categorization is made for neighbourhood variable to guide future studies on choice of variables to be used in studying the relationship between ULUPRs and housing values/RPIRs.

Neighbourhood planning: encompasses planning the various neighbourhoods within the study area housing the estates to be sample. Others include zoning (greenbelt, urban growth boundary), traffic, orientation, and distance to nearest school.

Neighbourhood interior amenity encompass availability of public service like drainage, electricity, property management, sewerage, paved street (tarred road).

Neighbourhood exterior environment include: surrounding facilities like streetlight, sport facilities, sewage plant, telecommunication, property management (external to house), distance to arterial road, surrounding environment.
While on the location categorization the variable could be group to include.
Distance variable indicating accessibility to public and social service including proximity to hospital, bus stop, subway station, police post, parks, and street light.
Distance variable showing accessibility to place of employment including proximity to work place, city centre.
Distance variable indicating accessibility to disamenity including proximity to garbage dumps, earthquake fault lines and distance to slums.
Conclusively, this study has demonstrated that the impact ULUPRs on housing has an aesthetic component which affect the price/rental premium paid (positively or negatively) for property in residential market globally. The desire for amenity effect on structural, location and neighbourhood housing attributes are on the rise and outweigh the disamenity. This study call for research on ULUPRs and RPIRs of a developing nation like Nigeria with history of ineffective urban land use planning regulations from the purview of tenant and buyer of residential properties to unearth their peculiarity in urban studies.

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Potentials of Effective Urban Planning as Tool for Disaster Risk Reduction in Nigeria

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Abstract
In the last couple of years, disaster occurrence, both natural and human-induced are increasing worldwide. The magnitude of these disasters and the severity of their impacts have become sources of concern to development analysts and disaster risk managers. This study highlights that unlike what obtains in many other parts of the world such as Europe, North America and South East Asia that are particularly ravaged by natural disasters such as landslides, earthquakes and hurricanes amongst others, the disasters commonly experienced in Nigeria as in many other sub-Saharan African countries, safe for perennial flooding, are mostly human-induced disasters. In spite of the low frequency of natural disasters in the country the frequency and severity of human-induced disasters in recent times has become worrisome. This study therefore, emphasize that many of the this kind of disasters such as building collapse, fire outbreaks, pollution and epidemics occur in the country as a result of the inappropriate pattern and poor land-use planning and uncoordinated physical development activities, particularly in the urban areas. The paper therefore, highlights the relevance and utility of effective urban land-use planning and physical development tools such as land-use zoning, prevention of unwholesome and incompatible land-uses amongst others as veritable tools or measures for the prevention and minimization of human-induced disasters in the Nigeria.

Keywords*: Disaster, Effectiveness, Potentials, Risk reduction, Urban planning*

INTRODUCTION

The magnitude and scale of disaster occurrence worldwide and associated losses in the last decade has become increasingly worrisome and of great concern to development planners. Several countries of the world had witnessed at least one major disaster or the other in the last couple of years. While some parts of the world, particularly South East Asia, Europe and North America had experienced strings of natural disasters such as hurricanes, typhoons, mudslides, earthquakes and flooding of varying magnitude, other parts of the world, particularly sub-Saharan Africa have had to contend with series of human-induced disasters (GFDRR, 2010). While the losses associated with many natural disasters can be greatly minimized with timely prediction, adaptation and proactive settlements relocation measures, those occasioned by human-induced disasters are somewhat entirely preventable where effective urban planning is institutionalized and entrenched. Unfortunately despite the relative low occurrence of natural disasters in Nigeria, safe for occasional flooding, the country has had to contend with a multitude of human-induced disasters and calamities that are otherwise entirely preventable with effective urban development planning. These include building collapse, road traffic accidents, fire disasters, epidemics of several dimensions and flooding associated with poor urban planning and development (Ogundiya and Amzat, 2008).

The types of human-induced disasters perennially experienced in Nigeria are to a large degree hardly experienced in many parts of the world where effective urban planning and development are institutionalized and entrenched. As a result, many of the cities and towns in such countries are relatively safe, secured and livable such that many have become comfort zones of some sorts to their residents and visitors alike. It is therefore, the opinion of this study that if identified urban development planning measures and practices with disaster risk reduction (DRR) components are effectively institutionalized and entrenched in all parts of Nigeria, the large number of lives and property worth several billions of Naira annually lost to disasters would be saved.

CONCEPT OF URBAN PLANNING

Urban planning is increasingly becoming a dynamic profession, activity domain and branch of knowledge. As a result, the term urban planning has been given varying definitions and interpretations. It has also been given different names and appellations such as land-use planning, urban and regional planning, spatial planning, physical planning and town planning, just to mention a few. One of its earlier and most widely accepted definitions was offered by Kebble (1969) who described it as an activity concerned with the spatial ordering of land-use (both in the rural and urban settings) for the purpose of creating functionally efficient and aesthetically pleasing physical environment for living, working, circulation and recreation. Kebble (1969) further elaborated that urban planning is the art and science of ordering the use of land as well as siting of buildings and communication routes, amongst others, so as to secure maximum practicable degree of economy, convenience and beauty. Earlier in 1965, Davidoff and Reiner had defined planning as a set of procedures undertaken in making choices among alternatives and also in determining the future course of action. Patton and Reed (1988) described urban and regional planning as a discipline and profession concerned with forces that influence the quality of life from the neighbourhood down to the region, state and nation, employing systematic and creative approaches to address and resolve social, economic and physical problems of the neighbourhoods, localities, cities and the larger regions.

What is clear from the above definitions is that urban planning is not only dynamic but is also seriously concerned about human welfare and the condition of the environment in which they live. It can thus be argued that both in orientation and practice, urban planning seeks to create the best possible environment for man's living and for carrying out his various social, economic and other activities. If this is so, then central to urban planning is man's utmost safety, comfort, convenience and wellbeing. In its core principles, urban planning is disaster-preventive and safety-enhancing. Urban planning is therefore, regarded as an art and science concerned not only in allocating appropriate spaces to various activities (land-use planning) but also recommending appropriate locations for these activities so as to derive the utmost practicable benefits from them both in the present and in the future. If the foregoing is valid about urban planning, then it is a veritable tool for disaster risk reduction (DRR) if effectively carried out. Given the emerging scale and magnitude of disaster occurrence in Nigeria, particularly those regarded as human-induced, urban planning can be adapted to minimize likely disaster risks in both the rural and urban areas long before they rear their ugly heads.

History of Urban Planning in Nigeria

The emergence of modern urban and regional planning in Nigeria is intricately associated with colonialism. Although the various indigenous communities in different parts of the country through their *Obas*, *Obis* and Emirs as the case may be, had traditional methods of regulating land-uses and physical development in their areas prior to colonialism (Aluko, 2011), modern urban planning as it is practiced today emerged during the colonial period (Onifade, 2010). When Lagos became a British colony in 1861 there was the need to make its environment more conducive for the expatriate staff of the colonial government to live and work, particularly given the poor sanitary condition of the island then. As a result, the very first attempt made to regulate the physical development of the colony was in the form of enactment of the Town Improvement Ordinance in 1863. Although the coverage of the law was restricted to Lagos, its main focus was the regulation of physical development and urban sanitation (Oyesiku, 1997). Other ordinances also focusing on various aspects of urban development and control in the Lagos area were to follow in 1904 (Cantonment Proclamation), 1917 (Township Ordinance) and 1928 (Lagos Town Planning Ordinance).

The very first urban planning legislation that covered the entire country was the 1917 Township Ordinance which was enacted following the amalgamation of the Southern and Northern Protectorates in 1914. The main focus of this Ordinance was to establish the broad principles of municipal responsibility which was graduated according to the importance of the community. Therefore, the Ordinance was to serve as the legal basis for the development of the towns for most parts of the colonial administration in Nigeria as it gave clear guidelines for the construction of buildings and control of physical development (Oyesiku, 1997). However, the 1946 Town and Country Planning Ordinance was actually the planning legislation that was later to define and shape physical development control and regulation in the country. For a very long time, the law therefore, had pervasive influence on the way and manner various urban planning activities were carried out and implemented in many parts of the country for the rest of the period of colonial administration and after. In fact, the law was in operation for over forty-six years as no any other major physical planning legislation with national coverage was promulgated until 1992. However, the fact that the 1946 Town and Country Planning Ordinance in its actual operation was selective and segregational in nature had been expressed as it focused mostly on the planning and development of colonial-established European Reservation Areas, while many parts of the native towns where the indigenous people lived were neglected and haphazardly developed (Oyesiku, 2007).

Despite the criticisms relating to its operations however, the 1946 Town and Country Planning Ordinance laid the foundation for modern urban planning in Nigeria. Even the 1992 Urban and Regional Planning Law which succeeded it and was packaged by Nigerians to reflect the need and aspirations of the country drew widely from its contents and modalities. However, in spite of its wide reaching provisions, the 1992 Urban and Regional Planning Law has done little to stem the ugly face of cities and urban settlements and haphazard nature of physical development in the country. As at the end of the 2015 while no state in the country had fully implemented the Law, many others such as Edo, Benue, Ekiti, Enugu, Imo, Ondo, Plateau, Taraba and Yobe had only done so halfheartedly. As a result, particularly with the unprecedented trend of urbanization and high population growth rates in the country, urban planning cannot be said to have influenced the growth and development patterns of most urban areas in the country. There are series of urban planning issues and challenges confronting many parts of the country and which have therefore, deprived her off the benefits and potentials associated with modern urban planning. The next section of this paper focuses on some of these issues and challenges.

Urban Planning Issues and Challenges in Nigeria

Urban planning in Nigeria in the present circumstance cannot be regarded as effective and therefore, its full potentials as a tool for disaster risk reduction (DRR) is yet to be fully harnessed. If fully deployed and carried out by the most qualified and well trained practitioners, it has huge potentials in several respects to minimize the gamut of risks that triggered human-induced disasters in the country. The current challenges affecting urban planning in Nigeria are many and varied and include the following.

Ineffective Urban Planning Administrative Framework

The major planning legislation that is expected to drive urban planning administration in Nigeria is the 1992 Urban and Regional Planning Law. The law is not only comprehensive but also clearly defines the levels at which urban planning should be carried out in the country, while also assigning specific roles and responsibilities at these various levels. In addition to several other provisions bothering on land use regulation and development control, in specific terms, the law made explicit provision for plan preparation and administration at the federal, state and local government levels. However, this crucial legislation which was expected to have

far reaching impacts on urban planning administration in Nigeria is yet to be fully operationalized and implemented in several states and local government areas of the country. As a result, urban planning is still very weak and half-heartedly carried out in many states across the country (Aribigbola, 2008).

Poor Urban Governance

One of the glaring manifestations of the non-implementation of the 1992 Urban and Regional Planning Law in Nigeria is the poor structure of urban governance in the country (Aribigbola, 2013; Omar, 2013). In many states of the country it is sometimes difficult to tell which specific agency of government is in charge of urban management as there are multiple agencies with overlapping responsibilities and which are in many cases ineffectively carried out. For instance, some states have Ministries of Housing, Survey and Urban Planning alongside such agencies as Urban Development Boards and Housing Corporations with overlapping functions and responsibilities.

Poor Urban Land-use Planning, Control and Management

As a result of the weak administrative structure for urban planning in many states in Nigeria, land-use planning are not properly coordinated and controlled (Aribigbola, 2008; Dimuna, 2010; Olajuyigbe & Rotowa, 2011). It is no surprise that many urban areas in the country, including some state capitals, are without master plans and other physical development plans expected to guide their growth and development. In cases where such plans exists, they are sometimes either moribund or haphazardly implemented. As a result, many neighbourhoods of the cities and towns grow haphazardly on their own without any control. Risky and sensitive land-uses are in many cases not separated from other non-conforming uses, just as they are located in the most inappropriate parts of the cities where they will be less impactful.

Poor Funding and Political Interference in Urban Planning Activities

Urban planning is not given its pride of place and funding in many states in the country (Aribigbola, 2013a). In many cases, urban planning agencies lack crucial facilities and plans to work with as a result of paucity of funds. Perhaps one of the reasons why urban planning has been ineffective in Nigeria is the constant interference in urban planning and related activities by the political class (Aluko, 2011). Instances abound where development proposals earlier refused approvals by the relevant urban planning authorities were forced to grant same on the promptings and directives of highly placed and influential government officials. This is one of the several reasons why non-conforming land-uses are sited side-by-side in many places across the country.

Widespread Growth of Slums and Informal Settlements

There is no any other manifestation of the ineffectiveness of urban planning in the country than the multitude and growing number of slums and informal settlements in the country. Not only are many neighbourhoods not planned, their development are also not properly controlled leading to the development of all manners of structures and contraptions that expose residents to various health risks and other challenges. This also explains why unlike many other parts of the world, Nigeria is more exposed to human-induced hazards and disasters. Many of the fire disasters, building collapse, epidemics and other forms of disasters are more widespread in such places that are improperly planned and developed.

Poor Urban Transportation and Traffic Planning and Management

Urban transportation and traffic planning and management in most cities of Nigeria has been regarded has very poor. Several studies (Oni, 2004; Asenime, 2009; Atubi, 2010; Moses, 2011; Solanke, 2013) have catalogued the numerous challenges of urban transportation and traffic planning and management in Nigeria. These include poor quality of road network, poor road

infrastructure, poor maintenance, insufficient investment in modern transport modes and intractable traffic congestion, particularly as a result of urban expansion and increased population. Others are noise and air pollution, increasing rate of road traffic accidents, elongated travel time and poor traffic law enforcement and management amongst several others. Almost all these urban transportation challenges can be attributed to poor urban planning and management.

Poor Waste and Environmental Management

Another manifestation of poor urban and environmental planning and management in Nigeria with serious implications on disaster occurrence is the almost intractable challenges of poor municipal waste management system. A whole range of challenges has been identified in the waste management stream in the country, from poor waste storage attitude to ineffective waste collection, transportation and disposal methods (Abdullahi *et al*., 2014; Amuda, *et al*. 2014; Gana and Ngoro, 2014). Instances abound where the outbreaks of diseases and epidemics in the country are attributable to the poor waste management system.

CONCEPT OF DISASTER RISK REDUCTION (DRR)

The concept of disaster risk reduction (DRR) emerged as a result of the increasing trend of disasters worldwide and the severity of their impacts. In most of the definitions of the concept of DRR, emphasis is placed on two major strategic approaches. These are outright prevention of disasters and where such is not attainable, efforts and activities should be emplaced to minimize their impacts. One of the most embracing definitions of DRR was offered by the United Nations International Strategy for Disaster Reduction UNISDR (2009) as the concept and practice of reducing disaster risks through systematic efforts to analyze and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.

DRR is the systematic development and application of policies, strategies and practices to avoid or limit the adverse effects of hazards. The fact that virtually all individuals and communities are vulnerable to hazards that leads to disasters in varying forms have been expressed and so do the fact that they possess intrinsic capacities to reduce the vulnerability (Ginige *et al*., 2009). Vulnerability is described as the physical, social, economic and environmental characteristics, conditions and circumstances of a community, system or asset which increases its susceptibility to the damaging impacts of hazards (UNISDR, 2010). It is therefore, believed by the advocates of DRR that policies, actions and activities can be put in place well in advance of hazards occurrence so as to lessen or mitigates their impacts where they cannot be entirely prevented. DRR therefore, seeks to create the consciousness of likely hazard risks in all development activities and factor this consciousness into its planning and implementation. In the face of massive challenges posed by unprecedented pattern of urbanization, huge population growth, technological innovations, climate change and inappropriate development measures, it becomes extremely important to enthrone all possible risk reduction measures so as to make the world a safer place for the human race by putting in place measures to check disasters before their occurrence. Urban planning and management where effective has inbuilt disaster preventive attributes and has become a veritable tool in DRR in many parts of the world.

DISASTER OCCURRENCE AND MANAGEMENT IN NIGERIA

Nigeria has had her fair share of both natural and human-induced disasters, particularly in the last two decades. While many countries in Europe, North America and the South-east Asia usually ravaged by several natural hazards, including typhoons, hurricanes, mudslides and earthquakes, amongst others had been able to emplace effective preparedness and mitigation

measures, same cannot be said of many countries in the developing world, including Nigeria. In many of these countries, timely prediction, early warning system, population relocation and disaster resilient urban planning and construction amongst several contemporary DRR measures have tremendously reduced the negative impacts of disasters. Unfortunately, Nigeria with little vulnerabilities to natural disasters has been ravaged by many unfortunate and often preventable man-made disasters, the type many developed countries have been able to tame with their pattern of effective urban planning, development and management. Safe for the perennial flooding (now increasingly associated with the effect of climate change) usually recorded in many parts of the country, Nigeria has not witnessed so many natural hazards that could have assumed the dimension of disasters.

Several kinds of human-induced disasters are on the rise in Nigeria spite of the institution of multiplicity of disaster risk management agencies and measures at various levels. The increasing incidences of human-induced disasters in Nigeria have been attributed to the impacts of unprecedented pattern of urbanization and high population growth rates and the increasingly deteriorating pattern of physical development planning and management. For instance, several deaths are recorded annually as a result of building failure and collapse attributable to the poorly regulated building construction process in the country. Akinyemi *et al.* (2016) compiled a list of 34 building collapse incidences said to have occurred between 1995 and 2015, 63% of which was reported to have occurred in Lagos alone. In addition to a gale of building collapse incidences in major cities of the country other major types of perennial human-induced disasters in the country attributable to poor planning and management include:

1. **Fire disasters**, **especially in major markets across the country**: Major market fire incidences have been reported across the country, including the Balogun Market, Lagos in 2015, Onitsha Market of 2019, Sabon Gari Market, Kano resulting in the destruction of about 3,800 shops and goods worth over 2 trillion Naira. This Day, a popular national tabloid of 13th May, 2016 reported that in a space of three months, 10 major markets across the country went down with goods and property worth trillions of naira. Several other fire outbreaks have been recorded in many residential and commercial areas across the country, owing largely to unwholesome practices and poor physical development. Popoola *et al.* (2016) also reported that about 5,127 persons have died between 1998 and 2013 across the country as a result of different fire disasters
2. **Road traffic accidents**: As a result of the several challenges affecting transportation and traffic management in the country earlier highlighted in this paper several lives are daily lost to road traffic accidents across the country. According to statistics obtained from the websites of the Federal Road Safety Commission (2017) a total of 110,471 lives were lost to various road traffic accidents across the country between 2000 and 2017, while a total of 487,265 victims sustained varying degrees of injuries within the same timeframe. Many of these road traffic crashes are preventable where good quality of road network exists and effective transportation and traffic management system are in place.
3. **Infectious diseases outbreaks**: The connection between poor solid waste and environmental management and disease outbreaks has been highlighted by several studies (Modebe *et al.*, 2009; Nwogwugwu and Ishola, 2019). As a result of the poor and ineffective solid waste management system in the country, many communities, particularly in slum settlements and poor neighbourhoods of the cities are often exposed to all manner of infectious diseases.
4. **Dam failures**: The country has also recorded significant incidences of dam collapse or failures, particularly in the northern part of the country. These failures have caused loss of several lives and property worth several billions of Naira. Lukman *et al.* (2010) and Ezugwu (2013) among other studies have listed some dam failures in Nigeria that resulted

in several deaths, displacement of thousands of people and destruction of properties to include the August 30th, 1980 Ojirami Dam failure; the Shiroro Dam failure of 1999 and September, 2003; the Tiga (Niger State) and Challawa (Jigawa State) Dams failure of August; and the Gusau Dam failure of September, 2006.

5. **Overcrowding and stampedes**: Ineffective crowd control and management are also known to have resulted in the deaths of a sizeable number of people, while scores sustained varying degrees of injuries and deformations. Notable of these kinds of disasters was the 2014 Nigerian Immigration Service recruitment exercises which took place across the 36 states and Abuja. A casualty figure of between 16 and 24 deaths were reported to have been recorded.
6. **Pipelines vandalism and explosion**: Notable instances of oil pipelines explosion include the Jesse, Delta State incidence of 18th October, 1998 which claimed 1,082 lives (Environmental Rights Action, 1998); Atlas Creek Island (near Lagos) pipeline explosion of 12th May, 2006. Over 150 deaths were reported. Other common instances of such pipelines vandalism resulting in multiple deaths include Abule Egba, Lagos which occurred in December, 2006 and over 500 deaths recorded (Ogundiya and Amzat, 2008).
7. **Bomb explosions**: Aside numerous bomb explosion incidences with substantial human and material losses attributable to the terrorist activities of the insurgent grou*p Boko Haram*, a major bomb explosion with devastating effects occurred at the Nigerian Military Cantonment in Ikeja, Lagos on January 27, 2002 leaving 800 military and civilian casualties and thousands others homeless (Popool*a et al*., 2016).
8. **Urban flooding**: Although flooding is often categorized as a natural hazard, majority of urban flooding in Nigeria can largely be attributed to poor land-use planning and management and poor physical development regulations (Adeleye *et al*., 2019). It is common place in Nigeria to see settlements or residential neighbourhoods either located on floodplains or lacking required drainage channels, thus making them very vulnerable to flooding, especially during the peak periods of the raining season. In many cities across the country a large number of the drainage channnels are known to have been blocked by improperly disposed solid waste materials (Folorunsho and Awosika 2001; Ologunorisa, 2004; Magami *et al*., 2014), particularly in the unplanned and poorly developed high-density and crowded neighbourhoods of the cities. The 2012 flooding incidence across the country was particularly historical and widespread as it was one of the worst in the country's history in terms of human and material losses with 363 people killed, 5,851 injured, 3,891,314 affected, and 3,871,531 displaced (GFDRR, 2013).

URBAN PLANNING MEASURES WITH DISASTER RISKS DETERRENCE ELEMENTS

Urban planning and management measures with DRR elements can be mainstreamed and institutionalized into the development process as a way of addressing the several challenges identified, particularly those associated with various development activities. These measures are classified into both structural and non-structural in nature. According to the UNISDR (2010) structural measures are any physical construction to reduce or avoid the impacts of hazards, or the application of engineering techniques or technology to achieve hazard resistance and resistance in structures or systems. Non-structural measures are those not involving physical construction which use knowledge, practice or agreement to reduce disaster risks and impacts, in particular through policies and laws, public awareness raising, training and education. The range of DDR measures and activities embedded under urban planning and management includes:

i. Land-use planning and management
ii. Land-use zoning
iii. Physical development control mechanism

iv. Promulgation of planning laws and regulations
v. Evolvement of planning standards and building codes
vi. Public participation in the planning process
vii. Resettlement planning
viii. Disaster resistance engineering construction works
ix. Development of green city
x. Smart urban transportation planning and management

CONCLUSION

In conclusion, it is apt to emphasize that as a result of the frequency of occurrence and severity of impacts of both natural and human-induced disasters concern worldwide is now increasingly shifting from disaster risk management to disaster risk reduction (DRR). While the former focuses on managing the risk of disasters and dealing with their impacts after their occurrence the latter is geared at building consciousness about risks associated with development activities and mainstreaming that consciousness into the development process so as to lessen such risks. Urban planning through its various measures, some of which have been highlighted in this study, where effectively instituted, has the potential to severely minimize if not entirely remove the development-related risks that triggers disaster events, particularly human-induced disasters. It is therefore, recommended that governments at all levels, particularly through their appropriate and relevant agencies saddled with physical development control activities begins to be proactive such that activities, conditions and circumstances that triggers the various human-induced disasters can be nipped in the bud before they manifests into disasters. This, in essence, is the main thrust of disaster risk reduction (DRR). It is further recommended that the appropriate physical development control agencies be staffed with qualified and well trained professionals while also providing them with all necessary tools and facilities with which to effectively carry out their activities.

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Analysis of Urban Densification and Housing Market in Bida, Niger State, Nigeria

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Abstract:

This study examines pattern of urban densification as an element of urban growth and how it can provide extra spatial information explaining variances of housing market of Bida. Census sampling techniques was adopted in sampling all 31,410, 46,489 and 47,394 buildings for the years 2008, 2013 and 2018 respectively and also 138 houses managed by the 3 registered estate firms in Bida. Data were collected using Google Earth to capture satellite imageries for the years 2008, 2013 and 2018, while handheld GPS was used to take coordinates of rental houses managed by registered estate surveyors and valuers. Point Density spatial analyst tool and Ordinary Kriging (OK) was used to analyse residential density and rental prices respectively, while Artificial Neural Network (ANN) was adopted to analyse and forecast residential density and housing prices with the aid of Map Algebra tool in ArcGIS. It was found out that the pattern of densification process confirmed urban economic theory for monocentric open cities, while OK model disconfirmed Alonso's monocentric theory. The ANN model revealed that residential densities increase shall continue along the urban – rural gradient thereby causing a transition of open spaces and low density areas in to medium and high density areas in the coming years, while rental prices of housing apartments shall continue to decreases with decreasing distance to the city centre. It was therefore recommended amongst others that there is the need for rational densification for urban development in order check the increasing residential density that reduces green and open spaces.

Keywords: *Urban densification, Housing market, Kriging, Artificial Neural Network,*

INTRODUCTION

Access to adequate and affordable housing is a current and growing problem in developing countries (UN-Habitat, 2011). In Nigeria, like in many other developing nations of the world housing problems are multi-dimensional. The problems of population explosion, urban drift, and the inadequacy of basic infrastructure required for good standard of living have intensified housing problems over the years (Mohammed & Aremu, 2017). Access to this basic need by the poor who constitute the largest percentage of Nigeria has remained a mirage and it needs to be critically addressed. It has been observed that the disparity between the price and quantity of housing on one hand, and the number of households and the money available to them to pay these prices on the other, this is a central issue in the Nigeria housing sector (Adedeji & Olotuah, 2012).

The cost at which houses reach the market goes a long way to determine affordability. Where the unit cost of houses is abnormally high only a few people are able to afford the houses. In the Nigeria housing sector, there is a very wide gap between income and housing market. This has almost wiped out the low-income earners from the housing market (Adedeji & Olotuah, 2012). However, urban densification is one of the major hindering factors.

Urban densification is as a result of increase the level of urbanisation of a limited area which causes challenges in the housing affordability due to the increase in price of houses, high rental values, high demand and shortage in supply to meet the need of the urban residence. Bida is experiencing urban densification which has attracted people from different parts of the country which has consequently led to increases in housing demand. The intensity of housing demand in the city has also resulted in increased house rents.

However, a large body of literature has formed on housing market (Leung, 2004; Wu, Deng, & Liu, 2014; Muehlenbachs, Spiller, & Timmins, 2015; Muehlenbachs et al., 2015; Yang, Hu, Li, Zhang, & Torres, 2017; Tupenaite et al., 2017; Zhou, 2018; Cameron, 2018; Cheung, Wetherell, & Whitaker, 2018; Wang, Wang, & Wang, 2018). For example, Xiao (2012) studied urban morphology and housing market with emphases on street network pattern appears to be

a fundamental determinant of house prices since street network pattern influences accessibility. Wang, Wang and Wang (2018) analyses the spatial patterns and driving forces of housing prices in China where multiple theoretical perspectives on housing demand, supply, and market, are combined to establish a housing price model to explore the impact of land prices on housing prices. These authors ignore housing submarkets.

Studies of urban morphology (densification specifically) in relation to the housing market are rare, due to the lack of a powerful methodology to quantify the urban form accurately (Xiao, 2017a). On this context, this paper employs conventional methods such as Artificial Neural Network, hedonic and spatial analysis methods to analyse urban density and housing market. By doing so, it attempts to make a significant contribution to urban scholarship by exploring how measured residential density associated with urban form.

However, the monocentric urban economic model (Alonso, 1964) and polycentric variants emphasize location, hypothesizing that house prices decrease with a growing distance to the CBD, but more recent studies show that distance to CBD has become less important or even insignificant, suggesting either that people no longer choose their residential location based on minimum travel cost to work or that work has significantly dispersed within cities(Xiao, 2017b). There are many literatures on housing market where few captured urban forms and housing market (Mohammed & Sulyman, 2019a). However, little have been done on urban densification and housing market.

This research shall seek to analyse urban densification and housing market of Bida and as well, assess the trends in urban densification and housing market of Bida for a period of ten years and predict future densification and housing market. Also, this study is of paramount importance because urban densification has either negative or positive impacts on the housing sector, most especially the housing market. It can therefore be stated that, the outcome of this research work would be beneficial, which shall focus on developing a methodology aimed at ensuring sustainable housing market aimed at providing affordable housing alongside proffering solution to ailing consequences of urban densification in Bida.

STUDY AREA

Bida town is a Local Government Headquarter in Niger State, located on the A124 highway (a regional road) linked Ilorin to Minna and Abuja. The LGA has an area of 1.698 km² and a population of 266,008 (NPC, 2006) with 9°05′N, 6°01′E, 9.083°N, 6.017°E, Coordinates. Bida is the second largest town in Niger State. It is located southwest of Minna, capital of Niger State, and is a dry, arid town. The major ethnic group is the Nupe. Bida is the headquarters of the Nupe Kingdom led by the Etsu Nupe. The town is known for its production of traditional crafts, notably glass and brassware. Bida is also known for its Durbar festival. It is also the home of the Federal Polytechnic, Bida (Mohammed & Sulyman, 2019b). The locational map of the study area is shown in Table 1.

METHODS

The required sample size for this research includes all building units in the entire study area which is 31,410 buildings, 46,489 buildings and 47,394 buildings for the years 2008, 2013 and 2018. Also total number of 138 houses managed by the 3 registered estate firms in Bida; Usman Maishera & Associates, Okoh Okuoma & Co. and Pat Egbeduma & Partners was sampled which includes; 60 one bedroom, 54 two bedroom and 24 three bedroom.

Data needed for this research were collected through interviews, physical observations, Satellite imageries and handheld GPS. Satellite imageries were captured to examine the residential density changes that occur within the study period. Handheld GPS was used in collecting coordinates of rental apartments managed by estate surveyors. Data on type of

housing, rental value, changes that occur in the rental years, location of houses and data on rate at which rent changes in different submarkets were recorded from the estate surveyors.

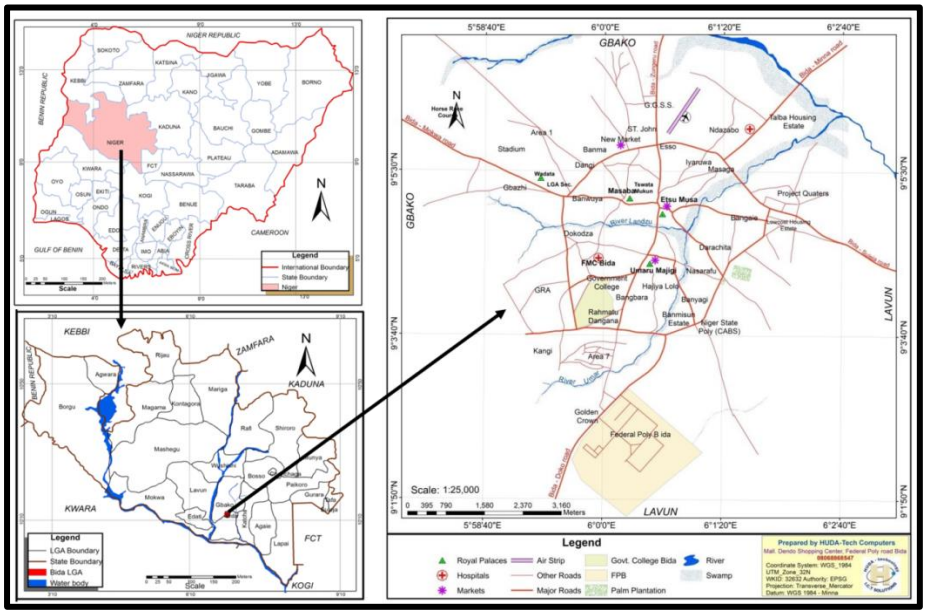

Figure 1: Locational Map of the Study Area
Source: Niger State Ministry of Lands and Housing

Point density spatial analyst tool of ArcGIS 10.6 was used to analyse residential density of the study area for the years under study. Geo-pressing procedure produces raster files for the densities for the year 2008, 2013 and 2018. This is adopted where 'buildings within a fixed distance *d* from *i*' is calculated in ArcGIS by using the 'Point Density' tool.
The interpolation method adopted was Ordinary Kriging (OK) using Esri's ArcGIS software to automatically select the interpolation parameters of the examined data. Rental value of residential rental apartment form group of X variables and space forming Y variable was interpolated with filled contours to show areas with higher rental values for a particular year.

ANN Model and GIS
Machine learning approach using ANN was adopted to analyse the changes that occur in the residential density and housing market within the 10 years period and forecast to 10 years. The ANN learns patterns of urban densification (using density raster cell counts) and housing market (using rental value raster cell counts); this information is then saved and used to forecast change in urban densification and housing market. The projected data from ANN was computed in a model built using Raster to polygon conversion of ArcGIS 10.6 Toolbox to produce maps for projected raster cell counts for both residential densities and rental prices to 2023, 2028 and 2033 respectively.

RESULTS AND DISCUSSION

As a result of residential densities increase along the urban – rural gradient, the observed increase in residential densities associated with the presence of restrictive spatial planning is in line with expectations from urban economic theory. However, in the study area the restrictive spatial planning is not in place. This analysis provides some empirical underpinning for city structures in line with the monocentric model. Similar pattern were observed by Broitman and Koomen (2015) who studied residential density change focussing on densification and urban expansion – that in urban development, increasing densities and number of housing units increases towards the city centre. Wang et al. (2019) find a similar importance for the growth

centres in their analysis of urban densification dynamics and future modes in south-eastern Wisconsin, USA. However, it can be inferred from the research findings that residential development occurs more in areas that are rich in amenities but in the study it occurs more in the areas with less or no physical planning regulations.

Findings of this study revealed that there is unique pattern of housing prices across the study period in most part of the town. The city centre which is referred to the CBD in this study has the lowest rental value through the study period. The study also shows the differences in rental value of apartments between the CBD and other neighbourhoods which continue to widen. For example, One bedroom apartments, in the year 2008 commands rental value of around N70,000 in GRA area and in the CBD it was around N15,000 to N20,000. Ten years later, rental value for one bedroom apartment increases to around N120,000 in GRA area and N28,000 around the CBD. This result is in conformity with the result by Cichociński and Dąbrowski (2013) but contrary to findings by D'Acci (2018) whose findings shows that housing value decreases with the increasing distance from the city centre. D'Acci' findings confirms Alonso's monocentric model.

However, general pattern from the geospatial model of this study demonstrate a unique housing prices pattern for the CBD while a divergence pattern for other areas. The model shows that housing prices in the Polytechnic area increases more than other regions for all types of houses under study and throughout the study period. Consequently, the model disconfirmed Alonso's monocentric model which suggests that housing prices decreases with increasing distance to the city centre but it provides a new dimension and perspective for understanding the spatial urban structure.

Geospatial data of residential density and housing rental prices were used in the data used for the Artificial Neural Network (ANN) model. The model focused on traditional urban economic model such as Alonso who states that densities and rental values increases with decreasing distance to the CBD. The model use techniques such as data augmentation, pre-training, and sparsity which allow train a large model with a relatively small dataset. The raster data sets were reclassed in equal specification as earlier explained in the methodology. The output of the model include was forecast data for raster class count values. However, ANN output data were used to forecast spatial morphology of residential density and housing prices. The outcome of the ANN and spatial model shows in Figure 2 that residential density of the study area shall continue increasing in the nearest future and shall not deviate from the Alonso's monocentric model. The study also revealed that densification may occur in the urban fringes but lower than that of the CBD.

The implication of this result is that residential densities increase shall continue along the urban – rural gradient thereby causing a transition of open spaces and low density areas in to medium and high density areas in the coming years maintaining its monocentricity. Therefore, it can be inferred that demand for housing shall increase along the urban fringes thereby attracting development of more housing apartments. But the consequential effects of this is that if there is no effective planning regulations that would check the uncontrolled development, the morphology of the town continue to grow in organic manner.

Also, the model suggests in Figures 3, 4 and 5 that rental prices of one bedroom, two bedroom and three bedroom apartments will maintain the trend of rents recorded between years 2008 to 2018 in the future. The geospatial model of rental prices earlier explained shows deviation from the traditional urban economic theory such as monocentric model of Alonso. The model therefore suggests that the trend shall continue in the nearest future against monocentricity.

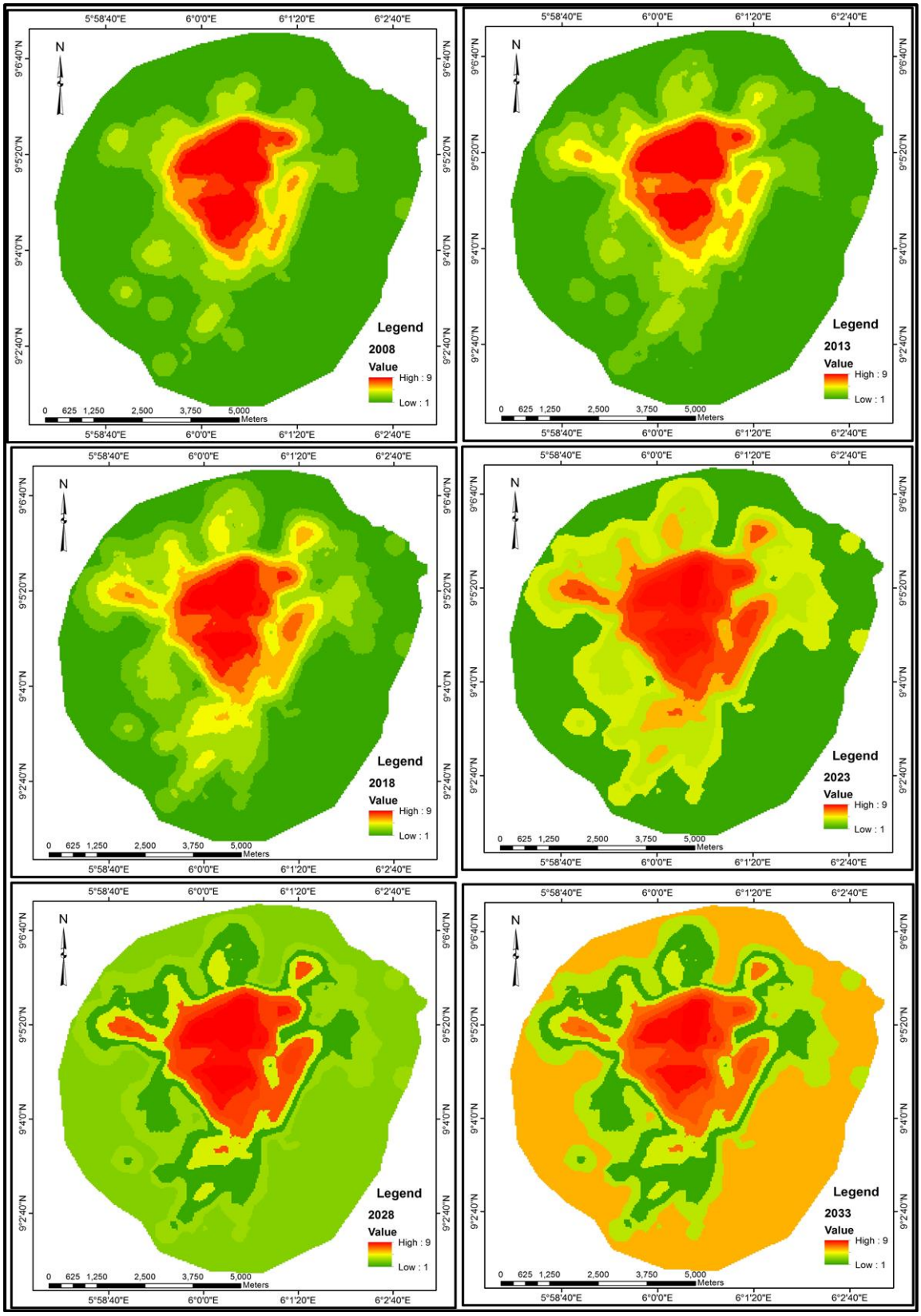

Figure 2: Forecast for Residential Density from the Year 2008 - 2033
Source: Field survey, 2019

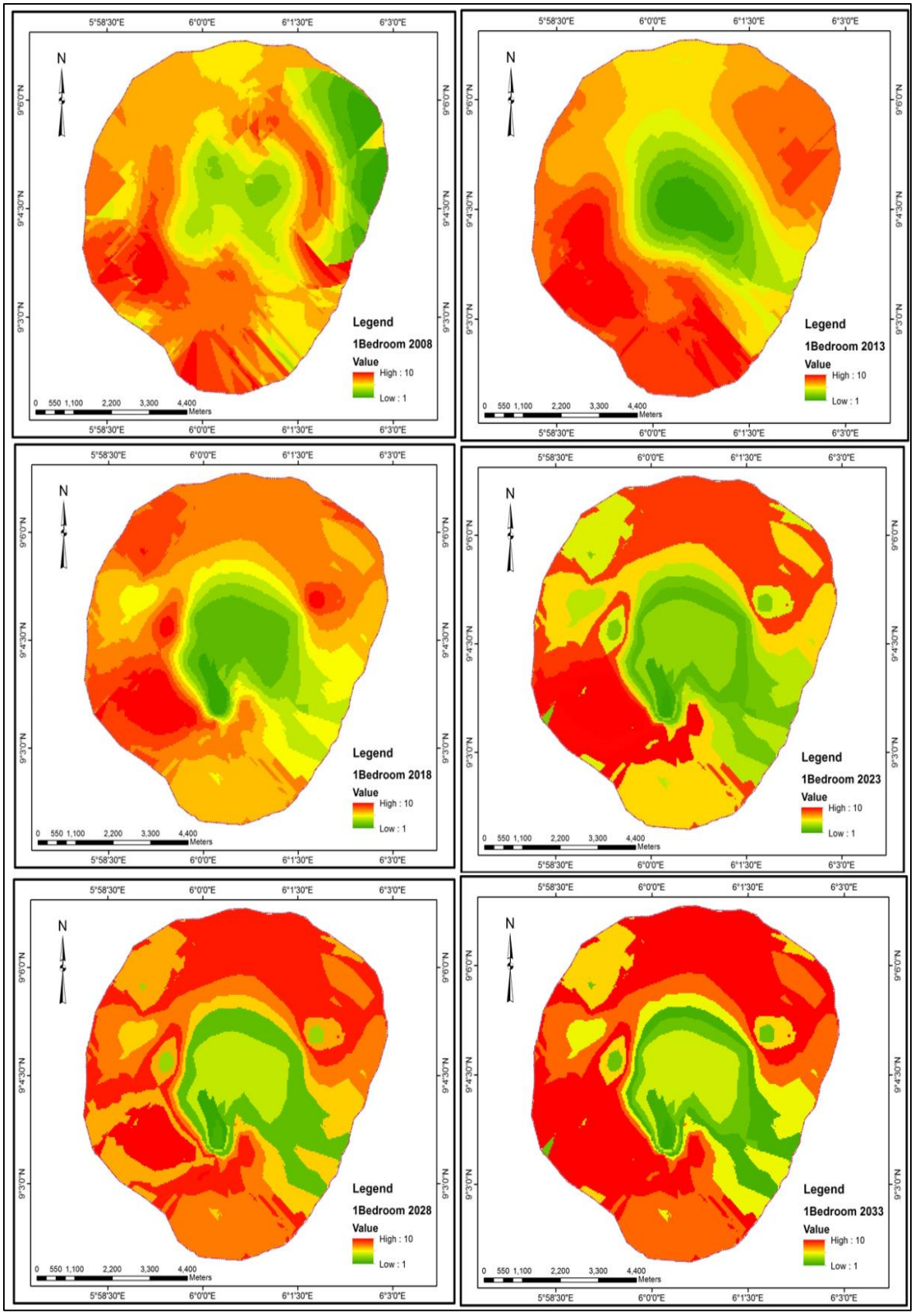

Figure 3: Forecast for One Bedroom Rental Prices
Source: Field survey, 2019

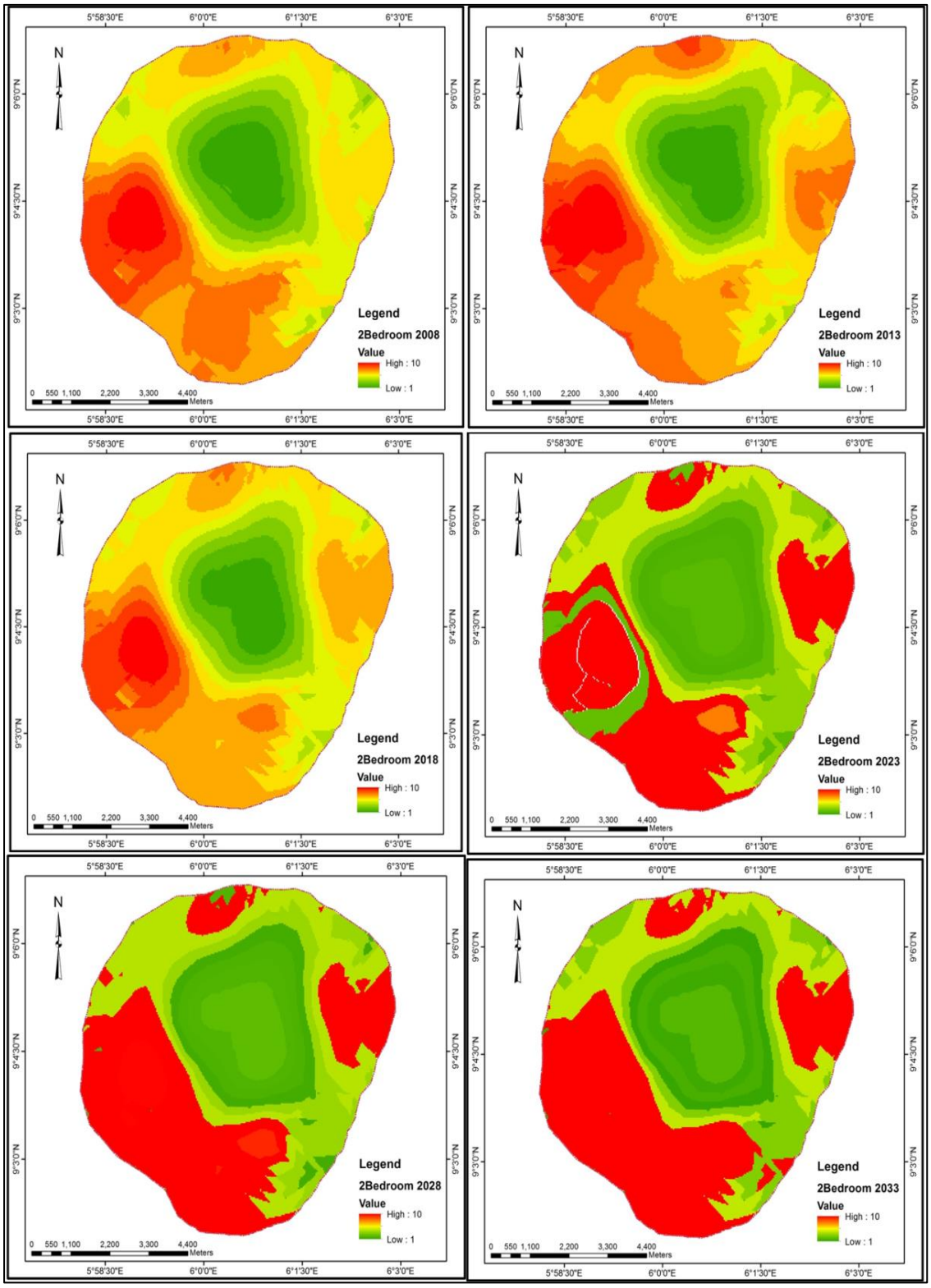

Figure 4: Forecast for Two Bedroom Rental Prices
Source: Field survey, 2019

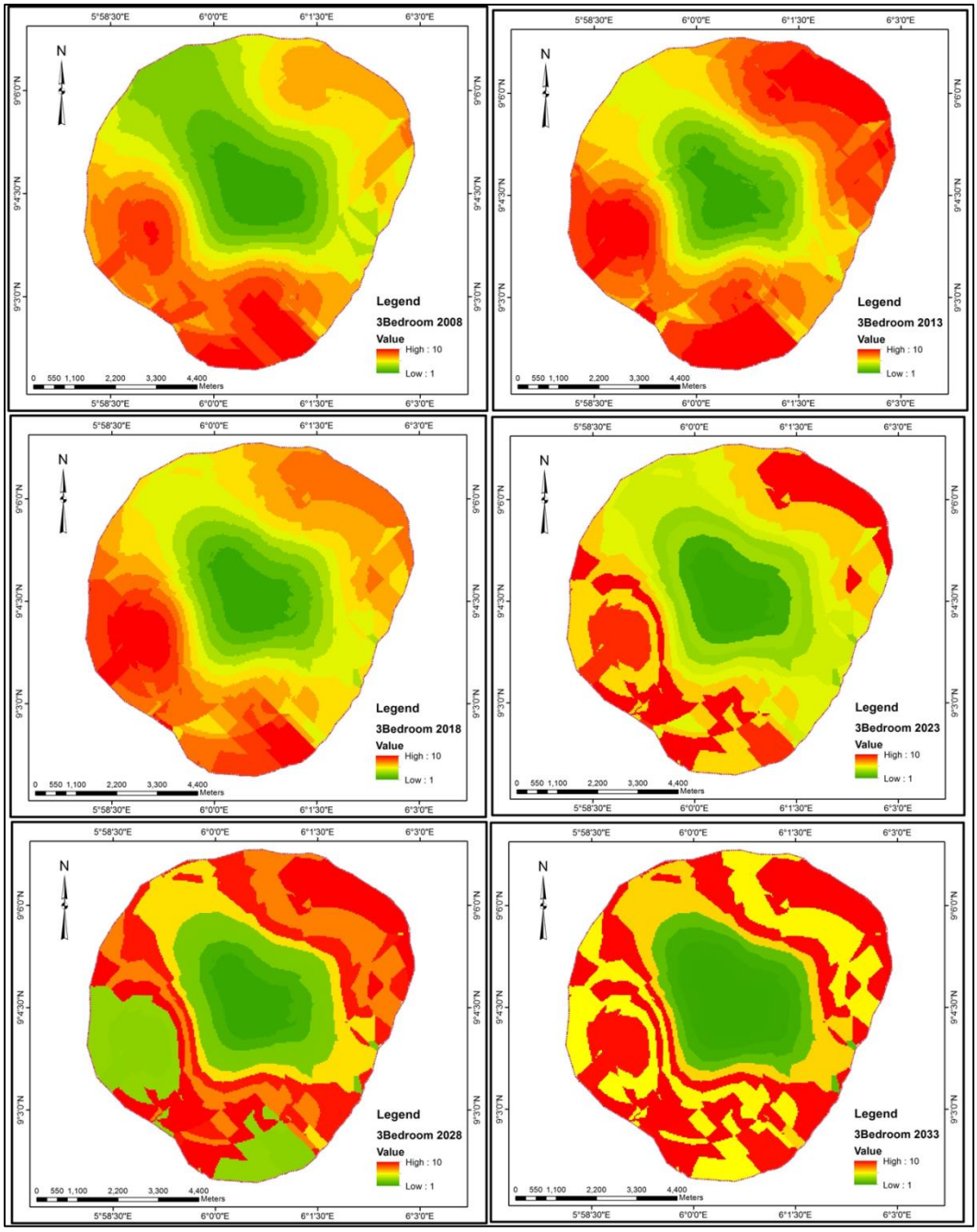

Figure 5: Forecast for Three Bedroom Rental Prices
Source: Field survey, 2019

This result implies that the Alonso's monocentric model as earlier disconfirmed in terms of rental prices shall continue in the future. Therefore rental prices of housing apartments shall continue to decreases with decreasing distance to the city centre. This also implies that this new dimension and perspective for understanding the spatial urban structure is how the study area would look like in the coming years.

CONCLUSIONS

From the study, the residential densities increase along the urban – rural gradient was observed which is in line with urban economic theory, though restrictive spatial planning is not in place. The study area depicted trends in the polycentric urban morphology contrary to urban spatial

structure of the monocentric housing market. However, general pattern from the geospatial model of this study demonstrate a unique housing prices for the CBD while a divergence pattern for other areas. This study further demonstrate the benefits associated with the use of GIS technology in housing research and the benefits obtained by modelling the spatial as well as the temporal dependence of housing price data. The residential densities increase shall continue along the urban – rural gradient thereby causing a transition of open spaces and low density areas in to medium and high density areas in the coming years maintaining its monocentricity. Therefore, demand for housing shall increase along the urban fringes thereby attracting development of more housing apartments. Also, the rental prices of housing apartments shall continue to decrease with decreasing distance to the city centre, and may continue to maintain its unique spatial pattern of housing prices in the coming years.

In line with the implication of findings of this research, recommendations are: that with increasing residential density and reducing green and open spaces it could have negative implications on the environment, hence the need for rational densification in urban development; need for the use of Machine Learning techniques such as Artificial Neural Network (ANN) in examining housing related issues such as density, housing demand and other related issues; need for the use of geospatial techniques such as Ordinary Kriging in modelling housing management studies, particularly, trends in the housing market.

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Exploring Community-Based Facilities Management Principle Towards a Sustainable Urban Land Management in Minna

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Abstract:
There are challenges with urban land management in many emerging economies of Africa. In Nigeria, one of such challenges is the existence of both customary and statutory interests in urban land. The Land Use Decree No 6 of 1978, currently known as Chap L5 LFN 2004, which empowers a state governor to acquire customary interest for overriding public interest, is faced with many challenges. Preliminary discussion from interaction with land officer at the Niger State Geographic Information System revealed that over 10% of state government layouts are currently being challenged by the natives in various courts across the state. The litigations revolve around issues of inadequate assessment index, inadequate compensation, protracted litigations arising from compensation assessments, all of which have contributed to unsustainable development of many urban lands. For holders of customary interest, there is the issue of development that lacks clear objective with regards to known planning principles, leading to slums, poor housing conditions, poor sanitation issues, incompatible urban land uses, poor property value, low environmental quality, and inability to have public utilities and social infrastructures amongst others in various communities. This study proposes a new paradigm that integrates both customary and statutory interest through community-based facilities management (CbFM) strategy to solve the urban land management problems. The study adopts a critical literature review of the core principles of community-based facilities management which include: service management, social inclusion, strategic development, economic longevity and environmental sustainability. The core values of these principles are recommended to enhance sustainable land management that will help in resolving the many challenges of urban land administration in Minna. It is intended that these principles be further tested with a range of case studies in Minna.

Keywords: *Community-based facilities management, Sustainability, Urban land management, customary land ,*

INTRODUCTION

Urban land management (ULM) refers to the administration of the urban area in order to enhance environmental quality, improve housing condition, environmental safety, and the value of properties (Ogundele et al., 2011). ULM is fundamental to the condition of the urban area which in turn influences economic, social and political development. The urban area is a hotbed of major economic development thereby attracting great population. Due to the unprecedented population growth, urban areas continue to grapple with numerous problems including housing, transportation, utilities and services, slum conditions, insecurity, and the general state of degradation (Turok and McGranahan, 2013; Aliyu and Amadu, 2017). The unprecedented population growth in urban area also increases the demand for development lands which are not readily available through the various government agencies that are saddled with the provision of lands.

Within the urban area, land can either be obtained from the statutory or the customary source. The statutory lands are held by the state governments who source them through the expropriation of customary interest upon the payment of compensation. The expropriated lands are planned and allocated to interested members of the public for various land uses. In most cases, the statutory land stock is rarely enough for interested members of the public. The customary lands are obtained through several means including direct inheritance, gift, outright purchase etc. Some prospective land owners who buy land from the customary sources formalise their acquisitions by applying for statutory title from the state ministry of lands. By this practice of formalising customary land holding, it is obvious that government is not involved in the planning of the allocations of the informal land market. Hence, the activities of the informal land market are not planned by the appropriate government agency.

The informal land segment is characterised by rapid growth in population and uncoordinated land acquisition activities (Magbagbeola, 1996). The land management authorities such as the urban development board and the development control agency are not also able to control land development because of the absence of requisite information from the informal market segment. The inability of land use authorities to control the development leads to several other issues including loss of revenue, insecurity, poor environmental condition, urban slum, negative perception that discourages business

creation and private investments (Alexander and Brown, 2006). The nature of these problems and their consequences have placed government and policy makers, especially land administrators in difficult positions to find lasting solutions to the issues bedevilling ULM.

Two major factors among several others hindering statutory land agencies from providing adequate land management revolves around expropriation and compensation (Birner and Okumo 2011). The two issues have led to several litigations between the acquiring authorities and the customary title holders (Shekwoaga, 2016). Preliminary discussions with land officers at the Niger State Geographic Information System revealed that over 10% of state government layouts involving several hundreds of plots are currently being challenged by the natives in various courts across the state. The litigations often take long time to resolve on account of slow judicial process. To make matters worse, illegal developments continue to spring up on disputed urban land through the informal land market, while the cases continue to delay in courts (Shekwoaga, 2016).

Consequently, basic planning rules are jettisoned, leading to the development of slums. Although the provisions of *Chap L5 LFN 2004* empowers the state governments to expropriate land for overriding public interest the exercise is often immersed in conflicts. The implementation of the provisions of the law with respect to expropriation and compensation have been contentious in many states of the federation (Omirin, 2003) including Niger state. Therefore, there is need to explore innovative strategies that will eliminate some of the challenges surrounding expropriation and compensation in ULM while enhancing a more functional urban area. This study explores the community-based facilities management (CbFM) principles with a view to developing a socially inclusive approach to ULM. The aim of the study is to evolve a sustainable urban area where ULM related litigations between government and natives is reduced to the barest minimum while reducing poverty and creating economic prosperity for both citizens and government.

LITERATURE REVIEW

Some of the ULM issues

The existence of both formal and informal land markets in African countries have resulted in different problems. Extant studies have highlighted several problems clogging the wheels of effective and rancour-free ULM (Ugonabo and Emoh, 2013; Hosaena and Austen 2016; Nwuba and Adoga, 2018). The commonest issues include the superiority of right concept which assumes that properties without statutory rights are perceived to be unsecured and less valuable than properties with statutory titles (Asabere, 2004). Due to the rapid growth in population and the limited supply of statutory land, uncoordinated land acquisition from the customary market has continued to thrive. Consequently, the development control authorities are not able to track all developments in urban area of Minna. Udoekanem et al. (2014) also highlighted bureaucratic bottle-necks in the documentation of land transactions, land registration and land titling as part of the problems of ULM. The bureaucratic control generally undermines community inputs while decisions on urban land are made through the top down approach. Also, many land expropriation programmes that over rely on executing the provisions of the land use decree without recourse to creating a diplomatic synergy with the community always face huge challenges (Cotula, et al, 2004).

Understanding CbFM

CbFM is a strategy where all stakeholders in a community work together to plan, deliver, and maintain an enabling environment, within which the local economy can prosper, quality services can be delivered, and natural resources are protected in order that citizens can enjoy a good quality of life (Alexander and Brown, 2006). Alexander and Brown (2006) defined CbFM as the management of facilities and the delivery of services that reflects the community and environment in which they reside and operate. Hasbullah et al. (2010) affirmed that CbFM is a concept that explores opportunities for the development of a socially inclusive approach to management of facilities. Michell (2013) emphasises that the principles of FM at a "micro", singular building, scale may be applied to a "macro", urban, scale, which can therefore create an effective standard in which to manage an urban precinct. Lilliendahl et al. (2011) argued that CbFM is a dynamic approach that can play a positive role in constructing changes in local neighbourhoods as well as facilitating innovative improvements. Nelson (2012) affirms that CbFM is a strategy that considers the impact and effects that facilities place on the existing

environment, empower local communities and spread economic prosperity to improve quality of life; promote local economic development and offer more value to the community. From the various perspectives of CbFM shared above, it is obvious that CbFM encourages a bottom up rather than a top down approach to management. It is a strategy that involves all the stakeholders in the project of ULM thereby reducing the chances of litigations. The core principles of CbFM include service management, social inclusion, strategic development, economic longevity and environmental sustainability (Timmo and Nelson, 2012). These principles and their applicability in ULM are discussed in further details below.

Service management

Service Management is a concept that ensures service delivery is demand-driven. In the business world, the service management concept enables organisations to leverage service delivery as a tool to sharpen their competitive business edge (Vandermerwe, 2000). Demand-driven service delivery enhances the relationship between service providers and their customers while reducing the challenges that managers face in the course of service delivery. Applying service management concept to ULM promises a more harmonized market that response to the demand of citizens. The strategy will enhance the formation of strategic alliance between the statutory land providers and the customary land holders in urban land provision. The strategic alliance will boost the confidence of the customary land holders while mitigating negative perception that would have come with government intensions to expropriate land.

Social inclusion

Social inclusion is strategy that encourages the creation of sustainable and inclusive communities that is mutually beneficial to all persons. CbFM explore opportunities for the development of a socially inclusive approach (Hasbullah et al., 2010). Social inclusion approach ensures that community voices of diversity are recognized and heard (Inclusive Cities Canada, 2004). Sands (2006) affirmed that the concept of social inclusion provides a useful framework that can help to guide the development of comprehensive strategies that support an all-encompassing participation of community members in a given project. According to Edmonton Social Planning Council (2004), inclusiveness enhances social health and quality of life, and consequently promotes economic prosperity.

Social inclusion involves five dimensions namely: diversity, human development, involvement and engagement, relationship to living conditions, and connection to community services (Inclusive Cities Canada, 2004). Diversity involves creating communal space and opportunities, physical access, cultural recognition, income levels, etc. in which individuals feel comfortable (Donnelly and Coakley, 2002); Human development factor ensures that people are fully involved and participate in the programs and services that support the development of their communities; Involvement and engagement emphasise that people participate actively in governance and decision making. Where people are not fully involved in a program, no matter how laudable, that program will suffer some failures.

Relationship to living conditions requires that government programs and projects are geared towards addressing prevailing important community challenges like affordable housing, community safety and crime, transportation, access to child care, employment and unemployment etc. Connection to community Services dimension of social inclusion emphasises that government develops synergy with organizations that may already be part of the lives of the people that they intend to serve. This may involve the police, urban development board, traditional institutions etc. This concept of social inclusion is favourable to forming synergy among land stakeholders than overdependence on the provisions of the land use degree. All these dimensions of social inclusion are in tandem with the promotion of CbFM principles in ULM. Hence, adopting a social inclusion approach to ULM will serve as a framework that can support organizational assessment and planning, resolution of important issues as they arise, and the evaluation of ULM processes (Sands, 2006).

Strategic development

Strategic development emphasis a development process that provides a sense of direction that leads to measurable goals. It is a core factor in CbFM because it emphasises the need for community stakeholders to have continuous access and maintain resilience long after any government activity has occurred. Accessibility and resilience have common denominator in the socio-economic life of citizens. Accessibility to land plays a vital role in poverty reduction and enhancing the status of groups and

individuals (Mustapha, 2007). After expropriation of customary lands, there is always problem of accessibility for the original inhabitants who owned the land. This is because there is a drastic land use change that alters the kind of economic activities (farming, mechanic, carpentry, vulcanizing etc) which use to be on the expropriated land. Hence, the displaced inhabitants become nomadic, leading to the loss of goodwill and patronage from their customers (Mustapha, 2007). The principles of CbFM envisages accessibility problem and therefore, encourages co-ownership, through removal of administrative bottlenecks, in order to facilitate a more sustainable accessibility to urban land. The CbFM principle on accessibility is also in agreement with the provisions of the 1999 Constitution which guarantee equal accessibility to land for all Nigerians irrespective of tribe, religion, occupation, level of education, political affinity and gender.

On the other hand, resilience is an assessment of how well a community or system continues to function during and after an event has occurred (Cox et al., 2015). Nelson et al. (2007) affirmed that resilience is the amount of change that a system can undergo and still retain the same controls on function and structure. The concept of resilience has been a subject of many studies including Hassler and Kohler (2014), Vale (2014), Tainter and Taylor (2014), Anderies (2014) and Bosher (2014). Hence, there are many perspectives from which previous scholars have assessed the concept. In the study by Bosher (2014), the concept of resilience was categorised into four including: resistance/robustness/absorptions; recovery/ "bouncing back"; planning/preparing/protecting; and adaptive capacity. In the case of CbFM, the major focus of resilience is on "recovery and bouncing back" because CbFM is more concerned with how the community can recover from the aftermath effect of government activities on ULM.

Economic longevity

Economic development as a core principle of CbFM emphasis the need for the people to have better economic condition long after the execution of any project in their communities. The concept stresses that government activities should bring some positive development instead of causing hardship for the people. When people participate in the development of their communities such as the construction of schools, repair of roads etc., the resultant effect is always positive on their economic development (Samad, 2002; Patrick et al., 2016). Studies have shown a correlation between community participation and rural economic development (Nekwaya, 2007; Aref and Redzuan, 2009; Patrick et al., 2016). Extant studies have reported that when communities participate with government on developmental projects, the socio-economic development of the dwellers, especially the poor people are uplifted (Laah et al., 2013). Particularly in land administration matters, extant studies recognise the importance of effective ULM in helping to alleviate urban poverty in the developing countries (Olima, 1997). Hence, the concept of CbFM perceive the enhancement of economic longevity of community inhabitants as crucial and should not be ignored in ULM programs.

Environmental sustainability

Environmental sustainability is crucial to FM and fundamental to the adoption of FM principles in community setting. Environmental sustainability factors such as air and water pollution, energy demand, solid waste generation, and many more can only achieve sustainability when the community is actively involved. Hence, CbFM recognises that the community must be involved in the planning and the execution of activities at the community level. The success of environmental sustainability is hinged on the wilful participation of the community dwellers. Considering that CbFM is the integration of people, processes and place, to develop, manage and sustain effective and efficient services, which meet the socio-economic and environmental objectives of the community, hence, the people become crucial to the attainment of environmental sustainability. This position agrees with extant studies which argued that community participation is an important determinant of success in project performance and sustainability (Steve and Olufemi, 2011; Olaleye, 2010; and Olukosi, 2002).

DISCUSSIONS

From the foregoing, it can be inferred that adopting the principles of CbFM in ULM will ensure a paradigm shift from the current ULM practice where the supply of urban land can either be from the

formal or informal market. The concept of CbFM in ULM will ensure that the supply of land is harmonized, and demand driven. The process will enable government to generate enough data for monitoring and control of development while investing the huge resources that would have been paid as compensation into infrastructure development. Furthermore, adopting CbFM principles in ULM will reduce the tension associated with expropriation and compensation on the strength of mutual understanding between the government and the customary land holders. The customary land owners will see themselves as partners in progress rather than waiting to be compensated for their interest in land. The rancour-free ULM process will avail the government the opportunity to evolve a more focused approach that guarantee measurable outcomes which can be used for further planning. It will also ensure that the socio-economic conditions of the customary land owners are enhanced because a CbFM principle encourages integration rather than outright displacement of the original inhabitants that characterise the current ULM practice. Finally, the adoption of CbFM principles in ULM will guarantee the promotion of environmental sustainability ideals with the corporation of all stakeholders in urban land.

CONCLUSION

The study set out to explore strategies through which the process of ULM can be less rancorous, in addition to reducing poverty and creating an economic advantage and opportunities for both citizens and government. The review of CbFM principles in ULM and their applicability to ULM showed that the issue of inappropriate expropriation method and inadequate compensation payment that are major issues in ULM can be avoided through the inclusive nature of the CbFM. Thus, the widespread practice of expropriating customary rights with little or no compensation will not arise . Furthermore, the needless litigations and associated expenses are curtailed while the formation of slums that arise from inadequate land management is reduced to the barest minimum. The study therefore, recommends that CbFM principles be further tested on practical case studies to further develop its applicability in real terms.

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Management Options for Some Selected Peri-Urban Areas of Kaduna Metropolis, Kaduna State, Nigeria

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Abstract:
*This paper examined the management options for Periurban areas of Kaduna Metropolis. It centered on the physical, economic, and social attributes of the study areas which were explored to provide strategic options for management of the areas, using Strength, Weaknesses, Opportunities, Threats (SWOT) analysis. Relevant published and unpublished works, and online articles/journals, were reviewed on various approaches for managing peri-urban areas. Physical surveys were conducted, which involved measurement of road length and observations of the condition of housing, economic activities and social characteristics. Interviews with few residents, General Manager of Kaduna State Urban Planning Development Authority, and the Assistant Director of Town Planning department of Kaduna Geographic Information Systems provided information on socio-economic characteristics, Authority's planning jurisdiction, and land use characteristics of the peri-urban areas via updated maps and gazetted guidelines respectively. An inventory of social services, infrastructure, were taken alongside formal interviews with the community heads of each of the selected peri-urban area. All these primary data, provided basis for situational analysis which were later used in SWOT analysis. The Strength, Weaknesses, Opportunities, Threats, **SWOT** analysis was carried out on the physical, economic and social attributes of five (5) peri-urban areas of Kaduna metropolis, and were juxtaposed to arrive at strategic options for managing the peri urban areas in Kaduna metropolis. Strategic options such as Strength-Opportunities(S-O), Strength-Threats(S-T), Weakness-Opportunities W-O), and Weakness-Threats (W-T) were reached by taking advantage of opportunities using strengths and neutralizing threats by minimizing weaknesses towards effective management.*

Keywords: *Analysis, Land use, Management, Periurban, Strategic options.*

INTRODUCTION

In developing nations, peri urban areas are rapidly growing (Nkwae, 2006).Most Nigerian urban centres were designed and planned for a smaller population and todays process of urbanization and physical development makes them ineffective in supplying serviced land for housing and sustainable livelihoods to the growing population (Habila, 2009).The city centres are mostly affected with a resulting effect on the outward movement of people to the fringe areas where cheaper residential lands and accommodation is available (Birley, Lock & Oluremi, 2003). Cities in all countries have to face the challenges posed by urban sprawl. The United Nations (2014) estimated that 'Population growth and urbanization are projected to add 2.5 billion people to the world's urban population by 2050, with nearly 90% of the increase concentrated in Asia and Africa. The process of urbanization will continue to grow exponentially in the coming decades. Peri urban environments are generally characterized by and subjected to multiple uncoordinated transformations in their physical, morphological, socio-economic, demographic, and functional characteristics (Audu, 2009). Department for International Development, DFID (1999), also reports that it is at the peri urban areas that transformations resulting from the dynamics of urbanization are highly concentrated. Consequently, poor physical development and environmental conditions consolidates complexes in managing the peripheral areas of cities (Salem, 2015), because more people are continuously added to this sector of the city. This situation further, subjects both settlers and physical growth to vagaries of mismanagement (Webster and Muller, 2002).

In the last century, Kaduna was established as an administrative and a military headquarter by Lord Frederick Lugard. Historically, the 1902 and 1910 cantonment proclamation act and Cummins' plan of 1913, and Max Lock Plan 1967 did not envisage a large metropolis

extending beyond the boundaries of its initial plan. However, some spatial symptoms suggests inadequate management plans that will sustainably manage the continuous expansion and development of Kaduna peri-urban. Ikudabo (1986), Tahir (1989), and Acholonu (1979) had approached the problems of peri-urban areas in 'bit by bit' approach as problems in themselves and focused on central areas of the City. Rich as these knowledge base are, there remain unanswered questions to how peri urban areas can be sustainably managed, and what management option can be best applied on single entities or composite existence on the multifarious issues regarding their environments. It is on this basis that this paper focuses on the characteristics, and management options for managing the peri-urban areas of Kaduna Metropolis. The focus of the paper is achieved through the following objectives: review of the strategies for managing peri urban areas; examining the characteristics of peri-urban areas of using SWOT technique and providing options towards the management of peri-urban areas of Kaduna Metropolis.

CONCEPT OF PERI URBAN AREAS AND STRATEGIES FOR MANAGEMENT

The origin of "Peri-Urban" is still unknown, but its importance rose over half a century ago because of the limitations in the dichotomy between rural and urban (Nkwae, 2006). These settlements are given terms such as rurban, suburban, urban fringe, urban periphery, peri rural and peri-urban areas. Among these terms peri-urban areas are commonly found in the literature and policy discussions (Nkwae, 2006). Peri-urban area may include land inside, or at the fringes of urban areas and lands further away from the city. This may, in turn, include both urban and rural land that is formally and informally occupied (Habila, 2009).

Nkwae (2006) further defined peri urban areas as "as a locus of abrupt tenurial transformation" of customary tenure in southern Africa. The customary tenure is based on traditions and customs of the local communities where land transforms institutionally from rural to urban, it is taken to mean a transition from customary to statutory tenure. Peri-urban may be a zone of smaller settlements, industrial areas and other urban land-uses within a matrix of functional agriculture (Nilsson, Bell, Aalbers, & Nielsen, 2013). Browder (1995), adds that peri-urban areas are traditionally featuring a diversity of land uses that vary in relation with their urban and rural linkages; that is transitional in nature more agrarian in orientation as one recedes from the urban center, inversely, "an agricultural land uses, employment and rural linkages and urban-oriented activities as distance diminishes to the city center".Varkey and Manasi (2019) adds that they areas of interface between the rural and urban areas with high potentials of rapid changes in its socio-economic, population, and built environment components. Wahab (2017) views that in developing nations, peri urban areas may be likened to informal settlements from the perspective of their illegal status development without official approval. The common feature of peri urban area from the definitions is that they are transition spaces with some degree of intermingling of urban and rural uses (Wandi and Magoni, 2017). There is a particularly strong difference between the peri-urban areas of developing countries characterized by pollution of land and waterways, poverty and informal settlement; and those of developed nations of Europe characterized by low levels of mobility, economic performance, landscape integrity and environmental quality. For both the developed and developing world, we must recognize the variegated and variety nature of peri-urban areas in terms their territorial extents and contents (Forsyth, 2012). Therefore, planning interventions and management of peri-urban areas must often take into account the diversity, dynamics and dialectics of these areas for possible opportunities and innovative approaches from elsewhere to pursue sustainable development.

THEORY OF PERI-URBAN AREA

Peri urban theory had been overlooked by scholars worldwide and the non-inclusion of variation in social change within the areas of different location is being ignored (Drescher, 2000, Varkey and Manasi, 2019). The Western states and United States scholars had theorise changes in peri-urban areas from the context of their settlements expressions since 1940's (Varkey and Manasi, 2019). Francois Perroux postulated Growth Pole theory in 1955 from the outcomes of rural–urban dialectics induced by economic activities and modernisation which is peri-urbanisation, a process of regional growth. He observed that economic growth from agricultural to industrial activities seemingly change the rural activities, capital and labour in those areas. The induced economic activity transforms into a character similar to that of core city and yet it is suburban. The theory states the dynamics of rural-urban transition within context of economic growth and modernity that could be of technological, income, psychological and geographical polarisation (Adamcik, 2002).

Some Planning Strategies in Management of Peri urban Areas

Historically, some planning strategies were employed to cope with problems associated with urbanisation and formation of metropolitan areas. These approaches includes:

Containment policy: Planners in Europe advocated for the control of urban sprawl through restrictions of development through the implementation of growth boundaries, green belts and limits to utility extensions. Europe widely used this approach as a major component for smart growth (Hall, 1973). Knapp and Nelson (1992) opine that the policy keeps tax revenue and jobs within the built up areas of the cities that seems to promote neighbourhood centers, racial stability and conservation of energy and preservation of green spaces outside of cities.

Dispersal Policy- New towns: The policy was a territorial planning approach in distributing land uses over spaces in order to discourage formation of one large metropolitan center (Edulbeham, 1996). These approaches differed from one region to the other. The British "new towns scheme" was one of such approaches, Bombay in India and Abuja capital city in Nigeria. The new Bombay Plan was initiated to stop migrants into the city via a 'counter magnet'.

Comprehensive land use plans: Simon (1990) defines land use planning as a tool used by decision makers to decide how to use land, through evaluating the land and alternative pattern of land use that meets the specified goals. Britain in 1908 prepared the first land use plan, after enacting an act for planners to prepare planning schemes. Today, most cities of the world have land use plans. Though it is classical approach of controlling the growth of cities and urban sprawl and has been effective in some countries where it was employed (Busa, 2003).

Integration (Upgrading). In the 1950's countries such as Peru, Indonesia and Turkey had adopted this approach of upgrading and integration to solve problems of blighted and informal settlements due to urbanization. The Habitat I conference in 1976 Montreal Canada and World bank and other international donors supported the movement. The 1990's provided new approaches to upgrading projects within the framework of city wide programmes.

The Nigerian Experience

Audu and Habila (2009) observed that Nigeria had experimented virtually all the approaches that were fashionable in the 1960's, 1970's, 1980's, and 1990's which includes slum clearance, sites and service schemes, slum and squatter upgrading, and master plans reviews. The urban fringe has been the provider of serviced land for housing in cities as only about 20 to 40 percent of migrants to the city can afford accommodation within the built-up city (Audu, 2009).However, the areas are devoid of physical planning challenges and poor environmental conditions that is appalling and life-threatening.

The Study Area

Kaduna is the capital city of Kaduna state, and its metropolis is located between Latitudes10°25'15"N and 10°36'08"N and Longitudes 7°23'31"E and 7°29'33"E (Figure 1.0). The state is situated almost at the central portion of Northern Nigeria and shares borders with Sokoto, Katsina, Niger, Kano, Bauchi and Plateau states (Figure 1.0.) By the 2006 Population census, the metropolis recorded a population of 1,139,578, at a growth rate of 2.53% and projected 2,057,078 people in 2015 (Federal Republic of Nigeria, 2009). The metropolis covers 260 km^2 area at extents of 13.7km from the Eastern to Western limits and 20Km North and South of the metropolis (Ajibuah, 2008). Kaduna Metropolis consists of two (2) Local Government Areas-Kaduna North, Kaduna South, and parts of Chikun and Igabi LGA's (Figure 1.1). Four (4) settlements were selected for the study, two from the northern, and southern parts of the metropolis in other to have a fair coverage. The areas are; Rigachikun and Rigasa for the Northern sector and Nasarawa and Sabon-Tasha for the southern sector.

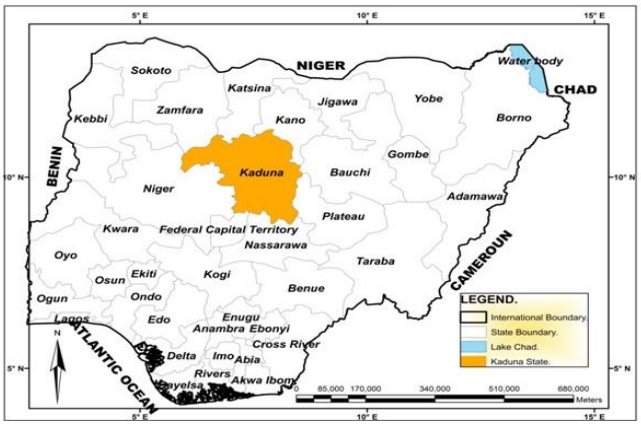

Figure 1.0 Nigeria showing Kaduna State.

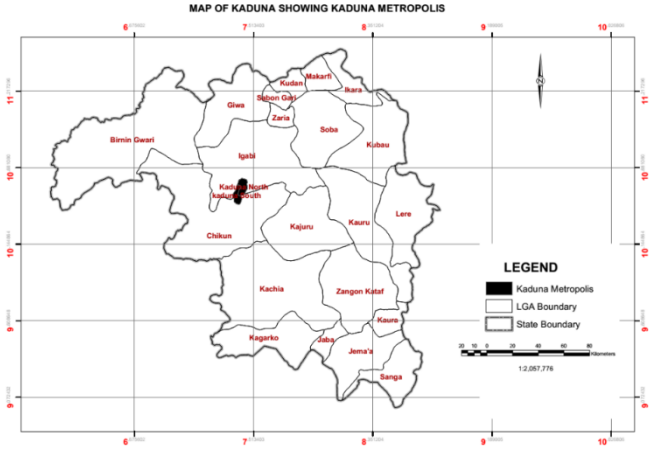

Figure 1.1: Kaduna: LGAs.

Source: Max Lock, Triad and Benna Associates 2010 and modified 2019.

METHODOLOGY

The peri-urban areas of the Kaduna were delineated on the basis of the Cummins and Max Lock Plan which consists of the two zones; the core areas and unplanned periphery. This study considered that settlements that emerged outside these foresaid plans and within 30 km planning radius as peri-urban areas of the metropolis (Figure 1.3). Four (4) peri urban areas of Kaduna metropolis were selected representing the northern, and southern sectors of the metropolis. Relevant published and unpublished works, online journals, master plans, and official census reports, past and present studies to form the conceptual framework and theoretical basis of the study on the subject matter. Land use characteristics were obtained from updated maps of Kaduna Geographic Information Services, KADGIS formerly Ministry of lands, Survey and Country Planning. Physical inventory, observations and measurement were carried out to obtain information on environmental conditions infrastructures and services. Four (4) community leaders and two (2) planning institutional leaders were the target population for interviews. Structured Interviews (one to one) were conducted with the community leaders 'Mai unguwas' one (1) in each of the peri-urban areas, General Manager (1) of the Urban Planning Authority, and the Deputy Director (1) KADGIS to acquire data on the social services available, economic activities and social attributes of their areas, information on planning jurisdiction, supporting documents for referral to KADGIS respectively. Descriptive statistics was used to analyse the data on the physical characteristics of the peri-

urban areas. The data on the socioeconomic, and Physical characteristics were used for situational analysis that aided the SWOT Analysis.

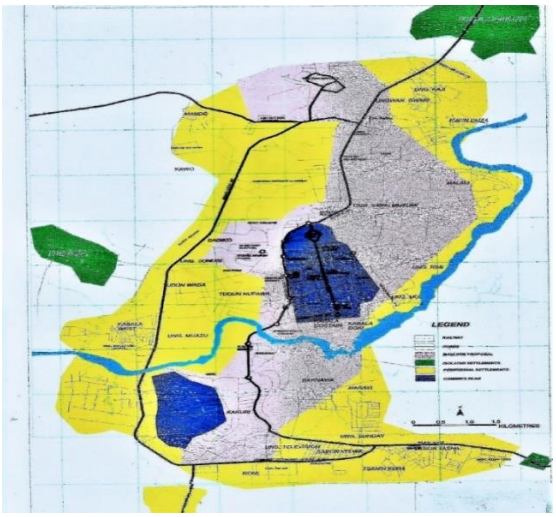

Figure 1.3: Peri-Urban Areas of Kaduna metropolis.

Source: Habila, (2009) and modified 2018

Strategic options for managing the peri-urban areas were deduced from the foresaid analysis. SWOT analysis evolved from Stanford Research Institute 1970 and was used as administrative technique and in a value-based management and strategy for marketing purposes. The technique is currently in use as an analytical tool in participatory planning approach because of its flexibility, optimum resource management and citizen participation. Therefore, effective strategies are arrived at by taking advantage of opportunities using strengths and neutralizing threats by minimizing weaknesses.

DISCUSSION

Land use Characteristics of Periurban areas of Kaduna Metropolis

Table 3.1 shows that land use mix is predominant in the Kaduna peri urban areas. Rigasa has the highest residential land use of 64% and Nasarawa has the least with 35% yet has 48.9% to Industrial, meaning that it is within an industrial suburb. Sabon Tasha has the highest commercial activities with 30% being on a regional arterial road (Kachia-Kaduna) and the least area is Rigachikun with 9.8% though has 42.6% of open spaces being an isolated peri-urban extension. Rigasa has the highest 14.4% of public land use. The northern part of the area do not have industrial land uses. While the southern part has predominance of residential and industrial land uses.

TABLE 3.1 LAND USE CHARACTERISTICS OF SELECTED KADUNA PERIURBAN AREAS

AREAS	INDUSTRIAL Ha (%)	RESIDENTIAL Ha (%)	PUBLIC/ SEMI PUBLIC Ha (%)	COMMERCIAL Ha (%)	OPEN SPACES Ha (%)
Rigachikun	-	20.9 (43.6)	1.9 (4)	4.8 (9.8)	20.4(42.6)
Sabon Tasha	-	80.6(60.6)	6.4(4.9)	39.9(30)	6.6 (5)
Rigasa	-	142.7 (64)	32.1(14.4)	41.1(18.4)	7.1(3.2)
Nasarawa	43.9(48.9)	31.4(35)	2.5(2.8)	9.4(10.5)	2.5(5.2)

SOURCE: MIN. OF LANDS, SURVEY AND COUNTRY PLANNING NOW (KADGIS), 2016.

Social Services in Kaduna Periurban area

Table 3.2 shows that education; health services and government presence are more in Sabon Tasha, and Rigasa respectively. Perhaps, the presence of major transport arterial Kachia road,

Nnamdi Azikiwe express way and Kawo road provides that initial advantage to the areas in siting of these services.

Table 3.2 INVENTORY OF SOME SOCIAL SERVICES

	EDUCATION			HEALTH			GOVERNMENT		
AREA	**Primary**	**Secondary**	**Tertiary**	**Patent store**	**Pharmacy**	**Hospital**	**Planning Authority**	**LGA office**	**Police post**
Rigachikun	2	2	3	2	-	-	-	-	-
Sabon Tasha	8	7	-	8	7	2	1	1	1
Rigasa	6	4	-	5	-	-	-	-	-
Nasarawa	2	1	-	3	-	-	-	-	

Source: Field survey, 2016

Transport Infrastructure in Periurban areas of Kaduna Metropolis

Table 3.3 shows an appalling situation of road infrastructure in peri urban areas that hampers smooth circulation for motorists and pedestrians and also increase in maintenance cost on repair of vehicles by motorists (Table 3.3).

Table 3.3: Transport infrastructure in peri urban areas

AREA	**TARRED ROADS (km)**			
	Good roads in Km	**Bad roads (Km)**	**Untarred roads(km)**	**Foot paths (km)**
Rigachikun	3.10	1.0	5	5.4
Sabon Tasha	4.32	3.1	8.23	1
Rigasa	4.20	6.3	4	3.6
Nasarawa	-	5.3	5	5
TOTAL	12.62	18.00	25.93	15

Source: Field Survey, 2016.

SWOT Analysis of peri urban areas of Kaduna Metropolis

The SWOT analysis here explores current situation and two (2) components were adopted from the internal (strengths or weaknesses) value creating or destroying factors and external (opportunities and threats) environments to the areas.

RIGACHIKUN

Physical Environment. Strength (S): Large vacant land, Most houses in good condition, Low traffic congestion, area is within the 30 km planning radius, and presence of a low density Public Private Partnership. **Weakness (W):** Houses are largely built with local materials, low infrastructure development Opportunities: Ecological funds from Federal Government, situated along a regional route, Presence of trade fair complex, 1 international school and 3 tertiary institutions. Threats: an isolated extension from the built up city encourages urban sprawl.

Economic Environment: Strength: .high entrepreneurial population, adequate land to accommodate activity systems. **Weakness:** unskilled labour force with low income earners, tertiary economic activities lack. **Opportunities:** Urban reforms such as KADIPA GEMS 3, DFID / World Bank funding. **Threats:** Affordable land prices, elite's presence creates segregation urban sprawl.

Social Environment. Strength (S): Presence of Governance & Community Based Development, Cultural homogeneity encourages morale towards achieving set goals. **Weakness (W):** Local administrative structure lacks capacity to cope with urbanisation rate, and increasing population puts pressure on inadequate facilities. **Opportunities (O):** participatory development approach is a huge prospect for Rigachikun. **Threats (T):** Lack of political will to address spatial and environmental issues by Government.

SABON TASHA

Physical Environment. Strength (S): Within the 30km planning radius with favourable terrain for development. Weakness (W): Poor Housing Conditions, traffic congestion, poor supply of urban services. Opportunities: Ecological funding from Government / internal funding for

water sanitation. Threats: Isolated from the built up city enhances urban sprawl and pollution from refinery.
Economic Environment. Strength: Presence of private estate developers, high economic activities, skilled labour force, income levels and Private Waste mangers services.
Weakness: Poor utility supply undermines economic prosperity, and effective revenue.
Opportunities: Ecological funds from Government and internal funds for water and sanitation, Physical development encourages increase in labour market and utility of materials. Threats: Proximity to Kaduna Refinery, large influx of low skill labour may skew the skilled labour available.
Social Environment. Strength (S): Presence of Governance & Community Based Development, Cultural homogeneity encourages morale towards achieving set goals.
Weakness (W): Local administrative structure lacks capacity to cope with urbanisation rate.
Opportunities (O): the presence a large population encourages metropolitan development.
Threats (T): Uncoordinated governance in the area.

RIGASA

Physical Environment. Strength (S): The area is within the 35Km planning radius of KASUPDA. Weaknesses (W): Poor Housing Conditions, traffic congestion, poor supply of urban services. Opportunities: Ecological and internal funding for water, sanitation and resource development. Close to the built up area of Kaduna puts it at advantage. Threats: Proximity to Central planning administrative areas makes it prone to demolition.
Economic Environment. Strength: a highly entrepreneurial, with income level are relatively high and presence of high investment in private housing. New Rigasa Train Station increases informal & local businesses. Weakness: Poor utility supply undermines economic prosperity, and effective revenue. Opportunities: Large population attracts investment. Threats: The area is within the built up area.
Social Environment. Strength (S): Presence of Governance & Community Based Development, Cultural homogeneity enhances achieving set goals. Weakness (W): Local administrative structure lacks capacity to cope with urbanisation rate. Opportunities (O): Participatory development approach promotes metropolitan development. Threats (T): neglect by authorities and poor institutional arrangement negatively affects the area.

NASARAWA

Physical Environment. Strength (S): Within the 35Km planning radius with favourable terrain for development. Weaknesses (W): Poor housing, and environmental conditions, pollution from industries. Opportunities (P): Ecological/ internal funding for water, sanitation and resource development. Threats: Traffic congestion, pollution from heavy duty trucks and industries.
Economic Environment. Strength: Population is highly entrepreneurial. Weakness: unskilled labour, and retired factory workers, poor supply of services. Opportunities: The new economic reforms have high prospects for the area. Funding for ecological/ environmental problems by government Threats: Unfavourable economic reforms / environment/ amongst other factors led to the closure of many industries in the area leading to derelict areas.
Social Environment. Strength (S): Governance & Community Based Development, Cultural homogeneity enhances achieving set goals. **Weakness (W):** Administrative structure lack capacity to handle urbanisation dynamics. High dependency ratio of youths and old retirees. **Opportunities (O):** social responsibility from industries can be beneficial for the area. **Threats (T):** Competition to access government's intervention and weak legal framework to enforce social corporate responsibility of industries.

Management Options for Periurban areas of Kaduna Metropolis

The identification of the management options strategically is derived from juxtaposing the strengths (S) and Weakness (W) of the internal environment and the Opportunities (O) and Threats (T) of the External Environment. The internal and external environment is explored to see how Strengths (S) can be employed to take advantage of opportunities (O) and how Weaknesses (S) can be overcome by taking advantage of opportunities. Strategic Option on Opportunities (S-O); how strengths be used to counter threats that tend to hinder achievement of goals and pursuit of opportunities. Strategic Option on Weaknesses (W-O) (strategic options); how weaknesses be overcome to counter threats that hinder the achievement of goals and pursuit of Opportunities. Threats S-T (strategic options) and W-T (strategic options).

Table 3.4: Management options for peri urban areas of Kaduna Metropolis.

RIGACHIKUN S-O (Strategic options)	Prepare a land use management strategy that will include phasing the development of vacant land over time and coordinate development with an extension programme and upgrading of infrastructure services and networks to suit the spatial progression of physical development with zones specifying densities. The area is located along major regional routes; growth corridors can be identified and established to encourage urban expansion so as to decongest the older settlements as well increase economic and development activities in the areas. Population homogeneity and social organization of the zone can be utilized by setting and promoting community-based projects.
W-O (strategic options)	Assist the administrators of these areas to improve local services by using funds as grants and subsidies. Request for farmland should be justified in relation to strategic land use plan to curb speculation. Labour intensive projects (agriculture and construction based) need to be introduced in area owing to its abundant low skilled labour, desired for the social benefit to the areas households.
S-T (strategic options)	The area falls under the 30 km planning radius and have local administrative structure. Metropolitan authority should be established with strategic responsibility with clear roles and functions between the metropolitan authority and subordinate administration. This will initiate proactive institutions in the area. Empower Local administrations on the understanding that the plans and programmes of subordinate administrations will comply with the guidance and directions given strategic plans this intervention would curb the activities of land speculators in the area.
W-T (strategic options)	Urban growth can be introduced after estimation of future land requirements and ensure implementation. Prohibit additional developments in zones with abundant vacant or unutilized land. Prepare land use / management strategy that incorporates transportation, economic, infrastructural, social welfare, and environment components and ensure strict implementation so as to counter the threat of investors developing the areas haphazardly. Establish a strong framework for sustainable development with clear stated aim and objectives and roles of institutions
RIGASA and SABON TASHA S-O (strategic options)	Public Private Partnerships can be adopted to enhance enabling environment for investment in housing and business. Population homogeneity and social organization of the zone can be utilized by setting and promoting community-based projects. Promotion of road construction and rehabilitation can be achieved with low costs due to relatively flat topography.
W-O (strategic options)	The new urban reform in the state can be taken advantage of to induce a spatial plan that will guide and control existing and future development. Environmental management plan & projects can be initiated to achieve a good environmental condition of the area. Perhaps, the 3Rs of waste inclusive in the management plan. Funds can be accessed from governments and international donors to improve the infrastructural network and services upgrade. Transportation strategy in terms of network improved network and traffic management systems, can be developed to discourage private vehicles use but improve on mass transits. Review cost recovery systems for existing infrastructure and utility services for a self-sustainable system. The young population (high dependency ratio) can be empowered via vocation and entrepreneurial training as well as population control techniques use. This will go a long way to promote inflow of resources into the area.
S-T (strategic options)	The area falls under the 30-km planning radius and have local administrative structure. Metropolitan authority should be established with strategic with clear roles between the metropolitan authority and subordinate administration. This will initiate proactive institutions in the area. Empower Local administrations on the understanding that the plans and programmes of subordinate administrations will comply with the guidance and directions given strategic plans. Decentralize job location areas to serve as a dispersal policy that will reduce the dependency of the area on the central built up area of Kaduna and the risks of losing labour and resources to the central area.
W-T (strategic options)	Establish a framework for sustainable development with clear aim and objectives and institutional roles in order to initiate by reversal, the unwillingness of government to develop the areas. Prepare land use / management strategy that incorporates transportation, economic, infrastructural, social welfare, and environment components and ensure strict implementation so as to counter the threat of investors developing the areas haphazardly. Prepare an elaborate infrastructure development programme can be promoted primarily to address the poor infrastructure base of the area which is unfavourable for economic activity and investment. Related to this intervention the threat of a depressed outside economic contributions into the areas can be reversed.
NASSARAWA S-O (strategic options)	As applied for Rigasa and Sabon Tasha
W-O (strategic options)	Consult with investors and business owners in order to facilitate appropriate actions for relocation of industrial sites to the outskirts of the metropolis (outside the 30 km urban boundary) or carry out a resettlement scheme for the entire area as an alternative where the foresaid can't be done.------as applied for Rigasa and Sabon Tasha---
S-T (strategic options)	--As applied for Rigasa and Sabon Tasha--
W-T (strategic options)	---As applied for Rigasa and Sabon Tasha--

Table 3.4 clearly shows that the strategic options occur in reoccurring pattern for all the peri urban areas of the metropolis. By extension the peri urban areas are having similar characteristics in the whole with some little dissimilarity.

CONCLUSIONS

The study has established that in other to achieve a proactive and sustainable development of peri urban areas of Kaduna Metropolis, strategic options approach of management should be adopted due to its capture of six (6) major components namely; institutional, Land use Planning, Economic development, Infrastructure, and Transportation that will ensure sustainable growth and management of peri urban areas.

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Assessment of Household Knowledge and Practice of Solid Waste Characterization in Kaduna Metropolis

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Abstract
The study investigated the extent to which household solid waste characterization practiced as a unit of waste management in Kaduna metropolis. It focuses on the knowledge, attitude and practices of households in waste separation, recycling and also analyzed the determinants of these practices. The survey was conducted on 384 households, using systematic random sampling techniques. The questionnaire utilized for the study targeted household heads. In the absence of a male household head, it was administered to the next eldest person irrespective of the gender. Descriptive statistics was utilized to understand the knowledge of segregation and recycling of solid waste and the reasons for engaging in solid waste characterization practices. Correlation analysis technique was employed to understand the determinants of household solid waste segregation. The findings indicate that, a significant number of households have knowledge of solid waste separation and recycling. However, they practice it for different reasons. The study observed that there is significant negative correlation between solid waste segregation and household income. This implies that an increase in household income is found to be associated with a decrease in the level of solid waste segregation. There was weak correlation between solid waste segregation and educational level. This implies that educational level has little or no influence on the practice of solid waste segregation in Kaduna metropolis. It was recommended that, the provision of garbage collection bins to households will be a good starting point and encouragement towards effective and efficient solid waste segregation in Kaduna metropolis.

Keywords: *solid waste, waste segregation, evaluation, household, recycling.*

1.0 INTRODUCTION

In the context of Integrated Solid Waste Management, waste is regarded both as a useless and as a useful material providing a potential source of income. It can in fact be the only free resource available to poor people, or urban dwellers, who cannot cut wood or use other common property resources available in the country. (Klundert and Anschue, 2001)

There are many categories of Solid Waste such as food waste, rubbish, commercial waste, institutional waste, street sweeping waste, industrial waste, construction and demolition waste, and sanitation waste. Solid Waste contains recyclables (paper, plastic, glass, metals, etc.), toxic substances (paints, pesticides, used batteries, medicines), compostable organic matter (fruit and vegetable peels, food waste) and soiled waste (blood stained cotton, sanitary napkins, disposable syringes) (Jha, Sondhi and Pansare, 2003)

As towns and cities around the world expand and population grows, so do volumes of waste produced increase and the challenges of solid waste change. As such, effective and sustainable waste management through source reduction, recycling goes hand-in-hand with good local governance and sound municipal management.

Solid waste disposed in a landfill requires a complex process which also leads to hazardous emissions. These have become a treat to human health and quality of life problems everywhere. A range of programs and policy instruments are required from the government and stakeholders to manage those waste appropriately in order to improve these problems. Creating an environmentally sustainable community requires an involvement of households in recycling solid waste (Kato, Tran and Hoang, 2015). As such, it is necessary to increase the public awareness of waste generation and separation at source which will reduce the volume of waste to be disposed. Not only waste reduction can help in reducing the expenditures and investment of government through lower collection, treatment and disposal but also protecting the environment (Walailak, 2002).

Waste minimization is a method used to achieve waste reduction, primarily through reduction at source by characterization, but also including recycling and re-use of materials. The benefits of waste minimization are both environmental and financial and wide in their coverage (Vipin, Jethoo and Poonia, 2012).

Most recent studies recommend the re-use and recycling of solid waste (Ekere and Drake, 2009; Banga, 2008; Pokhrel and Viraqraghavan, 2005). However, for any recycling activity to take place, the waste has to be characterized. One of the problems of waste management in Nigeria is the absence of a culture of waste characterization at the generation points.

This study therefore, seeks to evaluate the knowledge and practice of solid waste characterization by households in Kaduna metropolis. The study reviews relevant literature on solid waste characterization and its importance, examines the extent to which households have knowledge of the practice and their attitude towards it and then makes recommendation towards promoting the practice.

2.0 LITERATURE REVIEW

Solid waste is the unwanted or useless solid materials generated from residential, industrial and commercial activities in a given area. It may be categorised according to its origin (domestic, industrial, commercial, construction or institutional); according to its contents (organic material, glass, metal, plastic paper etc); or according to hazard potential (toxic, non-toxin, flammable, 1 radioactive and infectious (Sanjay, Ravi and Udaya, 2015).

Recycling is a method of solid waste management like controlling or incineration, but is environmentally more desirable (Ruzi, 2001). Recycling can help the economy by recovering and reusing valuable materials. Recycling reduces the amount of waste need to be collected, transported and disposed of, and extends the life of disposal facilities, which saves money to the agency (Ogwueleka 2009). Household solid waste characterization requires cleaning or washing the recyclables, sorting them into different materials, storing them in the household's premises, setting them out for collection or bringing them to drop-off zones.

Waste characterization refers to a solid waste management practice of separating and storing different materials found in solid waste in order to promote recycling and re-use of resources and to reduce the volume of waste for disposal. Waste recycling at the household level refers to resource recovery activities such as recovering or diverting wastes from the waste stream to re-use, sell, give away or compost in the case of food wastes. (Eugenia, Georgina and Ramil 2002)

Solid waste separation of reusable and recyclable material starts at the source of waste generation, by the residents, municipals or local governments (LG's) employees, private sector, etc. This is done in different ways and according to the considered system of waste collection such as curb side collection and/or drop off center.

There are many advantages for applying separation at source as pointed out (Lardinios and Fured, 2007).

- Achieving high separation rates.
- Promotes clean, marketable materials
- Limiting levels of contamination.
- Not disposing of recyclable materials as solid waste.

Waste recycling is often seen as an important aspect of an efficient and effective solid waste management system. Many substances in refuse have value. They include glass, wood, fiber, paper products and metals. Scientists have developed ways of recycling many wastes so that they can be used again. As defined by Schultz, Oskamp and Mainjeri (1995) recycling is the process through which materials previously used are reused. Recycling program can only be successful if people support and actively participate in it. As pointed out by Thomas (2001),

diversion of waste to recycling will depend not only on the number of people who participated, but on how well they do so and how effectively they participated.

3.0 METHODOLOGY OF THE STUDY

The study was conducted in Kaduna metropolis, Kaduna state, one of the major cities in Northern Nigeria. The city comprises of four local governments which includes Kaduna North, Kaduna south, Chikun and Igabi Local Government areas (Fig 1). Based on the 2006 census, the city has a population of 2,148,035. Data were collected from 384 households using systematic random sampling at an interval of one out of every ten households. Out of this, only 357 questionnaires were successfully retrieved (93% of the total households in the sample). Also, structured interviews were conducted to collect data on socio economic variables and other household characteristics such as people's knowledge, attitudes and practices. Descriptive statistics involving the use of frequency and percentages were used. Under the inferential statistics, a correlation analysis was carried out to determine the existence and extent of relationship between household solid waste characterization and income and educational levels.

3.1 Background of Study Area

Kaduna is an industrial center of Northern Nigeria, manufacturing products like textiles, machinery, steel, aluminum, petroleum products and bearings. Pottery is highly prized from Kaduna, especially from the Nok culture. It has a large market, recently rebuilt after an extensive fire in the mid-1990s. It is endowed with mineral resources such as clay, serpentine, asbestos, amethyst and gold. Additionally, it has been blessed with fertile land and a variety of crops.

Kaduna metropolis is in the heart of the Kaduna State of Nigeria. The metropolis comprises of four local Government areas which include Kaduna North, Kaduna south, Chikun and part of Igabi. The total population of Kaduna metropolis is 2 148 035 as projected from 2006 census to 2016.

3.2 Results and Discussion

General Characteristics of the Respondents

Majority of the respondents were females (66.2%). The explanation of this is based on the fact that female members of the households were the ones mostly found at home at the time of the survey. Furthermore, most of the husbands referred the questionnaire administration to their wives because they believe they are responsible for handling most of the household solid waste. The average household size is 8 people. 7.2% of the respondents had only Islamic education, 31.5% had primary education, and 33.3% had secondary education while the remaining 28% had different levels of tertiary education. The average monthly income per household 30 000 Naira.

Knowledge and Attitudes towards waste characterization

A total of 222 households (62%) admitted that they have heard about it waste characterization (table 1.0). They explained how they segregate solid waste into plastic bags, glasses, peelings (such as banana and yam) and metal. Others mentioned that waste separation also takes place at landfills. Furthermore, 143 households (40.1%) said that they heard of solid waste segregation from friends and relatives, 158 households (43.9%) heard about it from the itinerant buyers, 33 (9.2%) from newspapers and magazines and 24 (6.8%) said they had learnt about it at school.

Households also expressed their opinion about solid waste separation in their homes. 153 households (45.6%) said it was a good idea while 195 households (54.4%) said they did not

support it because they felt it is a waste of time and leads to dirty environments; hence, it should not be done at home rather at collection points or at the landfill.

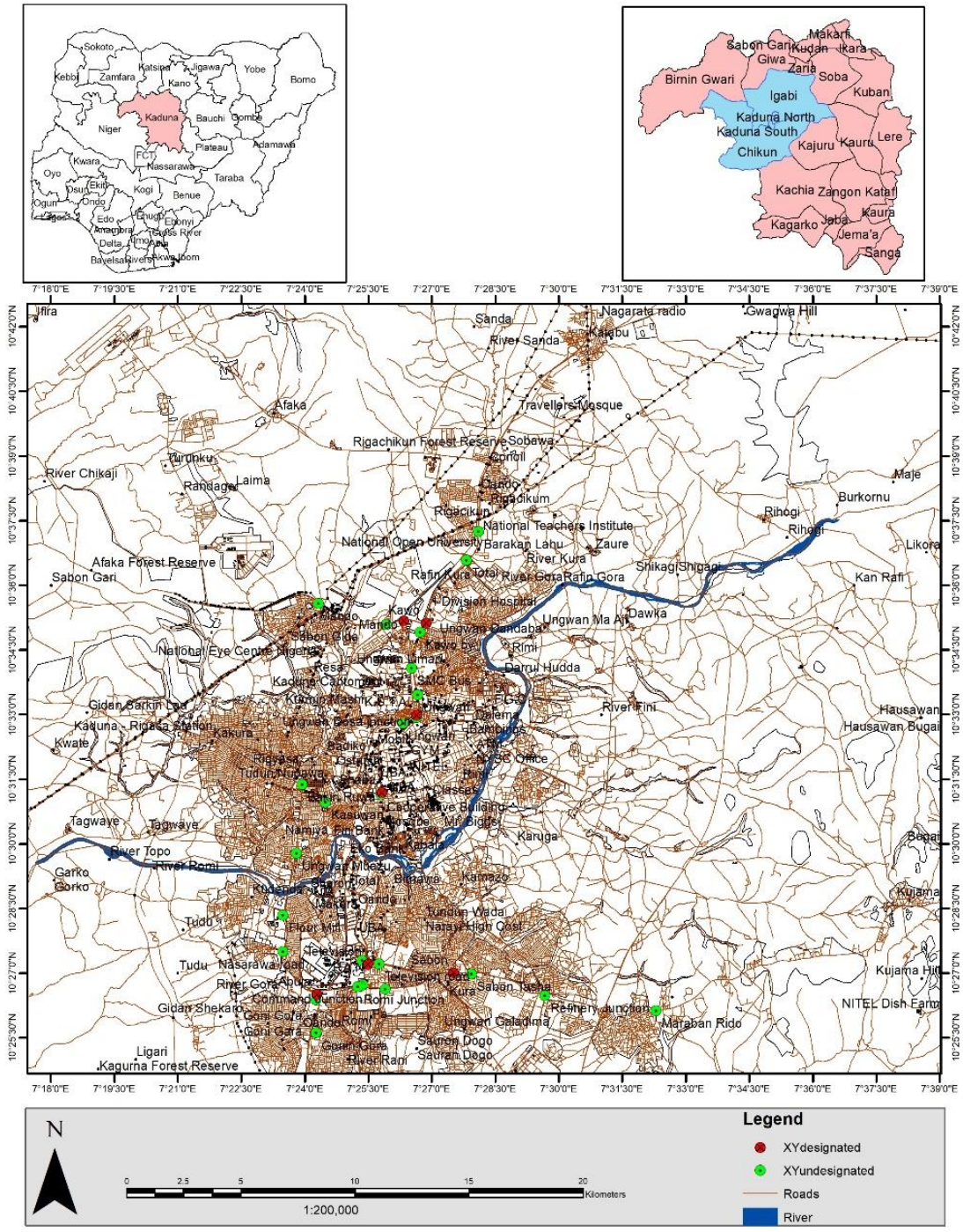

Fig 1: Kaduna Metropolis

When asked about their knowledge of recycling, 156 of the respondents (43.7%) indicated that they had heard about it. The main source of information was scrap (metal, plastics, paper, polythene and glass) dealers. Households were further asked if they had seen products from recycled materials. 344 of the respondents (96.4%), which represents the majority knew about recycled products from metal (charcoal stoves), building equipment, and domestic utensils (such as pots and saucepans), old tyres (ropes and fetcher) and straws (mats and bags). Households reported that the recycled products from metal were very useful to them. They

agreed that recycling of metals has benefits, because products from recycled metals are cheaper than the items produced from new materials.

Table 1.0 Knowledge of Segregation and Recycling

Knowledge of Segregation	**No**	**%**
Yes	222	**62.2**
No	135	**37.8**
Total	357	**100**
Source of information		
Family and friends	143	**40.1**
Itinerant buyers	158	**43.9**
Newspapers and magazines	33	**9.2**
School	24	**6.8**
Total	357	**100**
Thought About Household Solid Waste Separation		
Good Idea	163	**45.6**
Not a good idea	195	**54.4**
Total	357	**100**
Knowledge of Recycling		
Yes	156	**43.7**
No	201	**56.3**
Total	357	**100**
Knowledge of Recycle Product		
Yes	344	**96.4**
No	23	**3.6**
Total	357	**100**

Source: Authors (2018)

Reasons for Engaging in Solid Waste Characterization Practices

A breakdown of the reasons why households engage in the practice of solid waste characterization (table 2.0). Out of the 222 households involved in waste separation, 149 of the households (67%) participate in waste characterization because of the extra income earned from the separated waste while the other households separate waste because they want it to be efficiently disposed and some respondents do so to make manure from the separated waste. These represented 6.3% and 21.3% of the households respectively. Others had a combination of the other reasons (5.4%).

Table 2.0: Reasons for Engaging in Solid Waste Characterization Practices

Reasons for Engaging	**No**	**%**
Extra Income	149	**67**
Efficient Disposal	14	**6.3**
Manure From separated Waste	47	**21.3**
Others	12	**5.4**
Total	222	**100**

Source: Authors (2018)

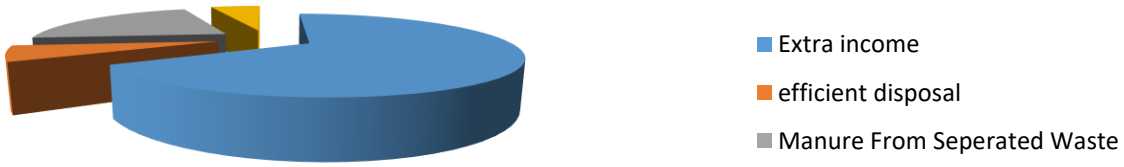

Fig 2: Reasons for Engaging in Solid Waste Characterization Practices

Households responded to mostly separating broken and whole bottles (18.3%), 31 households engage more with metallic waste (13.5%) and 46 with plastic waste (17.6%). The organic wastes are also sometimes fed to their own animals. The separation of organic waste and making good use of them is a sign that with time there will be no organic waste in the waste stream. This will reduce the amount of waste which is disposed at the landfill.

Table 3.0 Types of Materials Separated by Households

Materials	No	%
Plastic	46	**17.6**
Bottles	54	**18.3**
Metal	31	**13.5**
Organic	91	**50.6**
Total	222	**100**

Source: Authors (2018)

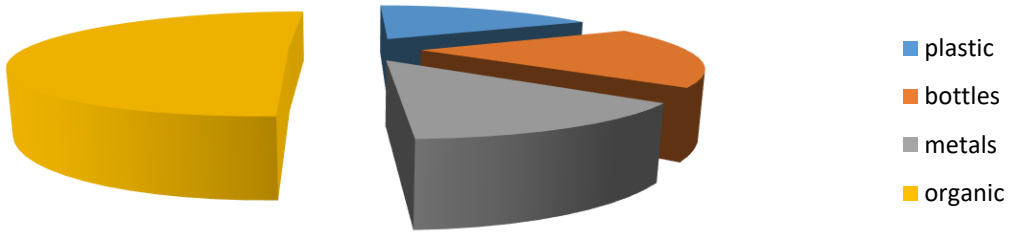

Fig 3: Types of Materials Separated By Households

Reasons for not Separating Solid Waste

The households gave various reasons for not practicing any form of waste separation activities are shown in table 3. Out of the 135 respondents who do not engage in solid waste separation, there reasons are; separation is time consuming (25.7%), lack of ready market for segregated waste (9.1%), not being able to afford separate bins for separated waste (14.4%), they do not see the importance of separating since the waste is dumped together on the same truck or at the communal containers (8.0%), and lack of space (18.5%). Other households said they did not separate the solid waste because they were already paying for waste collection (11.1%). They, therefore, did not see the reason why they should bother separating waste. The remaining 13.2% of the respondents had a combination of the various reasons outlined for not engaging in segregation.

Table 4.0 Reasons for not Separating Solid Waste

Reasons	No	%
Lack of space	25	**18.5**
Separation is not important	11	**8.0**
Separation is time consuming	35	**25.7**
No ready market for recyclables	12	**9.1**
Cannot afford separate bins	19	**14.4**
I pay for solid waste collection	15	**11.1**
Others	18	**13.2**
Total	135	**100**

Source: Authors (2018)

However, households not engaged in separating solid waste were asked what would be done to make them separate their waste before disposal. Some of them said if there is a market for the separated items (42.2%), while 35.8% said they can separate waste if, they are supported, by giving them containers where they will put the separated waste. The remaining 22% said they will engage in the practice when they have time.

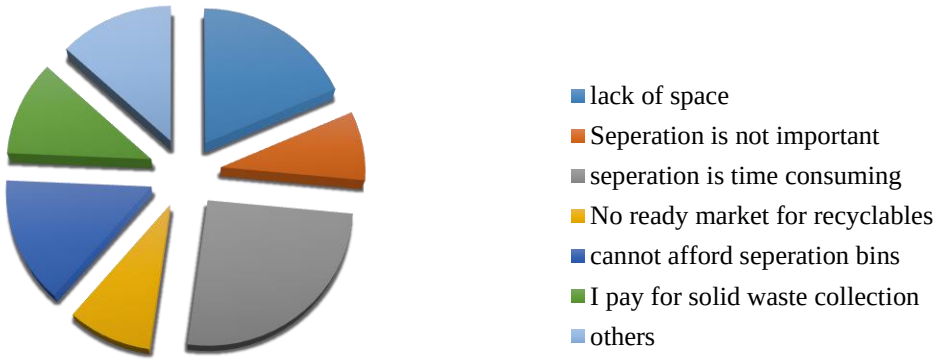

Fig 4: Reasons for not Separating Solid Waste

Determinants of Household Solid Waste segregation

The survey also reveals that most households who undertake waste segregation are usually in the low-income earners category. The rate at which these households engage in solid waste segregation is limited by their knowledge of the practices and its value. A correlation analysis was done to establish the strength of the association between solid waste segregation and the income level of households as shown table 5.0. The values presented are tested at 0.05 per cent significance. It was observed that the correlation between solid waste segregation and household income is highly significant with a negative correlation value of -0.735 and a p value of 0.002 which is less than alpha significance level of 0.005 and the correlation value is negative. This implies a close and inverse relationship i.e. as household income increases, the level of segregation decreases. There was little correlation between solid waste segregation and educational level. With a correlation value of 0.03. with a p value of 0.056 which is greater than the alpha significance value of 0.005. This implies that educational level has little or no influence on the practice of waste segregation in Kaduna.

Table 5.0 Correlation between income level, Education and solid waste segregation in Kaduna metropolis

	Solid waste segregation	**Income**
Pearson Correlation	-0.135	**-.393**
	0.002	**1.000**
Sig. (1-tailed)	.026.	**.026**
	Solid waste segregation	**Education**
Pearson Correlation	0.132	**0.03**
	0.056	**1.000**
Sig. (1-tailed)	0.395	**0.395**

Source: Author's computation (2018)

4.0 CONCLUSIONS

The study revealed that 222 of households (62.2%) are aware of solid waste segregation practices in Kaduna metropolis. This is mostly done for the financial gains. Households indicated that they did not separate solid waste because they could not afford separate bins for separated waste.

The results of the study show that waste separation is inversely related to household income, i.e. the practice decrease as household income increases. This stress the fact that solid waste characterization is mainly for the financial gains. Also, it was revealed in the study that educational level has no influence on the practice of solid waste segregation i.e. irrespective of

the educational level of the household, solid waste segregation is being practiced especially when there is need to make extra income as shown in the study.

Furthermore, the result shows that people are aware and have a positive attitude towards both separation and recycling of solid waste. The survey for this study shows that Households with less education are more likely to separate solid waste for financial gains. There is likelihood that almost everyone would be engaged in solid waste segregation with increased exposed to environmental education through the school curriculum. There is need to emphasize the protection of the environment in the curriculum at all levels of the education system.

5.0 RECOMMENDATIONS

If the Kaduna State Environmental Agency is to promote the practice of waste separation, provision of garbage bins to households will be a good starting point. This would encourage them to engage in solid waste segregation.

As a matter of policy, government should promote programs and policies that will encourage industries involved in the development of reusable products that will reduce solid wastes intended for disposal. This will boost the activities of the various stake holders involved in solid waste characterization. They include households, informal recyclers' scavengers and itinerant buyers. The recyclers are involved in producing low cost household and farm tools which have a big market among the low-income population. Their contribution in reducing waste is significant.

Effort must be made by the relevant Government agencies to promote the practice of solid waste segregation. This can be effectively achieved through a vigorous campaign about the benefits of solid waste separation.

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Assessment of Indoor Thermal Performance for Sustainable Senior Housing Facility in Minna, Nigeria

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Abstract
Recent research has linked recovery rate and prevention of ailments to the environment in which it is taking place. The objective of this study was to assess the effect of the condition/performance on the perceived Indoor Air Quality (IAQ) and the indoor air-related symptoms of senior's facilities. In this study, indoor air quality design considerations gotten from literature are used as a reference for comparison with what is found in the facility. The design considerations are expected to work as a reference for promoting environments that are adapted for the needs of older adults. The perceived IAQ and the related symptoms were collected by means of questionnaire survey and observation schedule among the senior adults in the facility. The performance was significantly low in the facility, having little impact on the quality of the indoor environment. Therefore, it is imperative that IAQ design consideration be adapted in the design of residential apartments for the elderly as it helps to prevent, promote and provide a curative remedy for their well-being.

Keywords: *Indoor air quality, Landscape, Respiratory health, Senior, Ventilation.*

1.0 INTRODUCTION

The main challenge for the future is the ageing population, particularly the increasing number of very old people (80 years and above). The old-age dependency ratio (those above or equal to 65 years) is projected to increase from 25.4% to 53.5% in the period 2008–2060 (European Commission, 2009). Increasing longevity can determine a rise in medical costs and an increase in demands for health services, since older people are typically more susceptible to chronic diseases. Nigeria, as one of the fastest population growth, is projected to become the third largest (Mudiare, 2013). Figure 1 shows the estimates and projections of population size, from 1950 to 2050, in Nigeria. There are studies that aimed to review the state of the Nigerian health care system and to provide possible recommendations to the worsening state of health care in the country (J Pharm Bioallied Sci., 2011). Due to technological advancements in medicine and water, hygiene and sanitation measures, Nigeria reports a significant increase in survival for persons over age 60. Figure 2 shows the estimates and projections of the number of persons over age 60, by general population and by sex, from 1950 to 2050, in Nigeria (United Nations 2002).

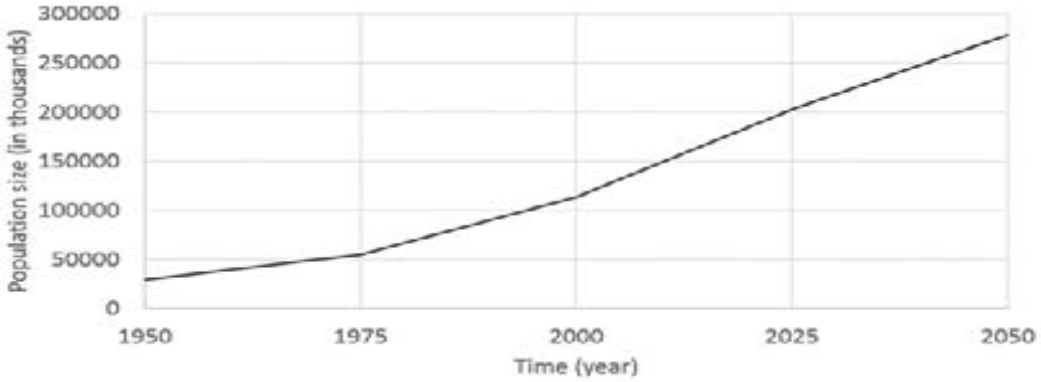

Figure 1. Estimates/projections of population size in Nigeria, 1950-2050(United Nations 2002)

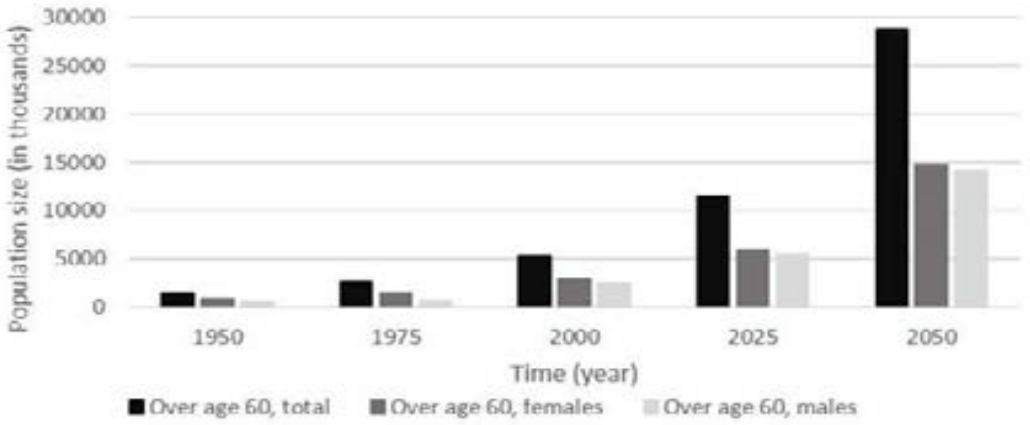

Figure 2. Estimates and projections of the number of persons over age 60 (in thousands), by general population and by sex, in Nigeria, 1950 to 2050. (United Nations 2002).

The well-being and health of the elderly particular in Nigeria, has been a source of concern to many researchers, and human rights organisations. Governments at the federal and state levels seem to have no concrete policies for the elderly in terms of social security, provision of social services, as well as health care. In 2000, Rivers state government in Nigeria embarked on a Free Medical Services (FMS) programme for the elderly population, as well as for children 0-6 years old. The elderly are also at higher risk of the effects of outdoor and indoor air pollution because of increased susceptibility and vulnerability. Outdoor air pollution is responsible for short-term and chronic adverse effects on cardiopulmonary morbidity and mortality in the elderly. [Bentayeb M, 2012]. There have been studies of poor acceptance of health care services as a result of infrastructural and personnel deficiencies; emotional and physical discomforts have been made. This has largely affected the utilization of Nigerian health services by the populace and it shows the need for better patient centred health care initiatives in policymaking and planning for health as well as the health care delivery services and programmes (Ephraim-Emmanuel, 2015). However, in industrialized countries, the elderly spend most of their time indoors [Simoni M, 2012]. 5% of those who are above 65 years and 20% of those who are above 85 years are nursing home residents (www.uscare.com). Due to reduced outdoor activities the elderly people are potentially more exposed to indoor air pollutants than the rest of the population. Therefore, keeping the elderly healthy by preventing illnesses due to poor air quality is a major challenge for many countries requiring a better understanding of the health consequences of the exposure to environmental factors, including air pollution [Bentayeb and Norback, 2015]. So far, respiratory health effects of indoor air pollution have been well documented in the general population; on the other hand, this important item was only seldom analysed in the elderly living in nursing homes and by few researchers' groups. The prevalence of the indoor air-related symptoms has been high also in developed elderly care residence.

The physical layout and design features of older adults' homes influence the way in which they use and perceive them. In addition, physical attributes of older adults' houses (e.g. inadequate ventilation, insufficient illumination) have long been associated with illnesses among the older adults (Viegi G, 2009); therefore, it could be expected that some environments are riskier than others for older adults. The principles of sustainable architecture are expected to work as a reference for promoting environments that are adapted for all, including the needs of older adults.

WHO (2005) identified indoor air quality as the eight most important risk factor and responsible for 2.7% of the global burden of disease. Indoor air quality causes more concern as places are crowded with people are at risk of spreading diseases caused by airborne bacteria.

Although several studies demonstrate the significant health impact of health-care facilities other diseases in Nigeria; most studies failed to investigate association between indoor air qualities which is most effective for the prevention of illness and promote a self-healing environment. This study seeks to assess the perceived quality of the indoor living environment in providing a safe and self-healing environment in Old People's Home, Minna. It sets out to examine how the physical features, indoor air quality parameter and building design of the indoor environment of older adults' residence may influence and be related to their reported health.

Study area.

This study is carried out in Minna, Niger State, situated at latitude 9°37' North and longitude 6°33' East. The northeast part of the city has a rock outcrop that acts as a physical constraint to development. Minna is 200 Kilometres from Abuja, the federal capital and covers 100,000 Hectares of land at the present development (Minna Master Plan, 1979). For the average weather in Minna, the wet season is oppressive and overcast, the dry season is partly cloudy, and it is hot year round. Over the course of the year, the temperature typically varies from 60°F *to* 94°F and is rarely below 54°F or above 101°F. The hot season lasts for 2.4 months, from February 2 *to* April 16, with an average daily high temperature above 92°F. The hottest day of the year is March 15, with an average high of 94°*F* and low of 71°F. The cool season lasts for 3.2 months, from June 23 to September 29, with an average daily high temperature below 85°F. The coldest day of the year is December 30, with an average low of 60°F and high of *89°F*. The study was conducted among the elderly residents in the Old People's Home, Minna, comprising basically of rooms on a floor building situated in a residential environment.(Tomasi, C 1998).

2.0. THEORETICAL FRAMEWORK

In fact, in sub-Saharan Africa, barriers to healthcare faced by older people have included elevated medical costs related to transportation to the health centre as well as disease management, minimal number of specialized centres for care, and lack of programs to optimize culturally- and age-sensitive care at federal health centres. Geriatric medical services are not prioritized in the Nigerian health system, which has been observed due to lengthy waiting time for healthcare appointments, low provider-patient ratio, and poor communication among elders and their healthcare providers, which may lead to unwillingness to utilize health services.

According to Abbas and Ghazali, 2012, natural views from windows, presences of green open spaces, colour, sounds, natural lighting and ventilation also gave more insight into the human crave for natural settings which reveals how nature offers an environment for healing from the effect of acquired stress.

2.1. Variables/ Design Considerations for Indoor Air Quality (IAQ) in the facility.

The environment is very important to enhance the healing process; therefore, it is imperative to identify how relevant IAQ considerations is to the senior's environment. The various ways in which these considerations can be experienced in the facility are as follows: natural ventilation/lightning in interior spaces, shading devices and a therapeutic environment. (Ghiaus et al., 2005).

2.1.1. Natural ventilation and lightning in interiors spaces:

Strategies of natural ventilation can be Single-sided ventilation, Cross ventilation and Stack ventilation.

I. Single-sided ventilation is induced by wind variation (Ghiaus et al., 2005). Air exchange in the room occurs in a way that air enters and exits the room from openings on one side. The air inflowing is the different masses of air flowing near the opening of the window at different

speed. Maximum room depth is 2.5 m times the height, approximate window height is 1.5 m, and window area is 1/20 of the floor area.

II. Cross ventilation is air crossing the room, entering from one opening and leaving from another opening. The second opening can be positioned in various ways and can either be windows or doors (Allard et al., 2005). Cross ventilation is driven by differences in pressure. Thus, a pressure difference is created between both surfaces which causes the air flow when opposite openings are created since the air is forced to flow from high to low pressure (Ghiaus et al., 2005).

III. Stack ventilation is a chimney-like process that creates a natural convection current that does not require fans. It involves the circulation of air through the entire internal environment of the building. The correct design of stack ventilation depends on the Neutral Pressure Level (NPL). This is the level responsible for balancing the airflow rates that enter and exit the building and tends to place itself closer to the largest openings. It depends on size and location of openings and indoor and outdoor temperatures. The higher the upper opening, the higher the NPL and therefore the higher the fresh air reaches the upper part of the building (Ghiaus et al., 2005).

Air vents and clerestory windows are not very common in Nigeria, although they are very effective for stack ventilation as hot air rises to the top, hence they provide a medium through which foul air is channelled out of the building, and could be integrated for effective natural ventilation of indoor spaces.

Natural lightning: Natural lightning is very relevant as it aids the smooth running of day to day activities. It is of utmost importance to the care givers as well as the patients. Based on the literature reviewed, natural lighting helps to ease the performance of visual tasks, controlling the body's circadian system which has a direct impact on senior's mood and behaviour. It also facilitates the direct absorption for critical chemical reactions within the body and in addition production of vitamin D in the body from early morning sun. Serotonin and melatonin among others are stimulated and suppressed in patients due to exposure to natural light.

2.1.2 Landscape:

Landscape is an area of land with natural sceneries or elements (McGarigal, 2017). It has the ability to reduce stress and boost human beings comfort and physical condition as people drift towards natural elements (Molthrop, 2011). Landscape configurations exist as healing gardens, therapeutic gardens, viewing gardens, edible gardens, roof garden, vertical gardens and indoor plant. Monasteries developed intricate gardens during the middle ages in Europe to convey images of calming distraction to the ill (Ulrich, 2002).

According to (Huelat, 2008) gardens offer several benefits to healthcare facilities, curtails stress and depression to healthcare users, valuable and more desirable quality, boosts up patient contentment, improves staff work productivity. Indoor plants effectively purify and filter the environment, as they absorb atmospheric gases and release oxygen therefore; they purify the air from the existing pollutants (Huelat, 2008). Their function encompasses releasing moisture, to prevent dryness.

2.1.3 Shading devices:

Shading devices could be added internally or externally in different orientations to control the excess solar radiation entering the window. Direct sunlight and glare is curtailed by the use of shading devices as the intensity is adjusted besides resulting in proper distribution of daylighting entering the room. (CIEE, 1997). Light coloured louvers or blinds are to be used with the purpose of reflecting out the sunlight. External shading devices are either anchored to the skin of the building externally or an extension of the external skin to block undesirable solar heat. They are to a greater extent more efficient than interior shading devices in

obstructing unwanted solar heat. Exterior shading devices includes: Fragmented horizontal overhang, Horizontal overhang with screening, Vertical or Fragmented vertical fins.

2.2. Respiratory Symptoms

Ageing leads to the deterioration of immune defences and lung function, and predisposition to respiratory infections (Viegi G, 2009). This requires a better understanding of the health consequences of the exposure to environmental factors, including air pollution. Adverse respiratory health effects due to air pollution are well established (Migliaretti G, 2007). Various studies have demonstrated a relationship between indoor and outdoor air pollution and respiratory morbidity and mortality in this age group at the general population level after stratification for age (Filleu L, 2004). A recent systematic review on adverse respiratory effects of indoor and outdoor air pollution in the elderly indicated that exposure these pollution leads to asthma and chronic obstructive pulmonary disease (COPD) and higher COPD mortality than in the rest of the population. Indoor temperature, relative humidity and carbon dioxide (CO_2) can also contribute to respiratory health issues (Fraga and Ramos, 2008). These few cited literatures clearly indicate that in order to create a safe and healthy environment for patient recovery, IAQ is an important issue.

2.2.1. Symptoms, Causes and Consequences of Poor IAQ

The American National Standard Institute's opines that some of the symptoms of poor IAQ in a health care facility includes, limited fresh air, temperature & humidity outside comfort zone, eye/nose/throat irritation, dry facial skin, respiratory infections, asthma, fatigue, headaches, increased allergic reactions, sick building syndrome – SBS. Also, potential causes of poor air quality include, reduced ventilation, building materials and furnishings, deferred maintenance, pesticides, housekeeping Supplies, and chemicals in Personal Care Products.

Consequences of Poor IAQ include; Health Problems, Reduced productivity, Higher Costs to Fix, Problems than to Prevent, Poor Public Relations, Liability Issues. The specific objective of the GERIE study (Geriatric study on health effects of air quality in nursing homes in Europe) (www.geriestudy.eu) was to contribute to filling the gaps in knowledge that exist in the field health effects of indoor air quality in the elderly. This was achieved by exploring the relationships of common indoor air pollutants and comfort parameters to respiratory symptoms and diseases among the elderly permanently living in nursing homes, who are potentially at high risk of exposure to air indoor air pollution from usual nursing home activities, such as cleaning and disinfection.

3.0. RESEARCH METHODOLOGY

3.1 Description of Case Study

The field study was conducted in Minna, the capital of Niger state. It was carried out with structured observation schedule, questionnaire administered to the residents and measurements of indoor thermal comfort and the nature of residential thermal environment of the old people's home located at Bosso district, in Minna, Niger State. The facility is a government-owned apartment built in 1986, adapted for good accessibility for people aged 70 years and over. The facility comprises 12 bedrooms, nursing station and other offices, the physical disabled apartment comprises of 25 bedrooms. It was selected as a case study because it could typify present situation of older persons living areas in Minna in terms of physical environment.

3.2 Data collection and methods

All the data used in this study are primary data; the data were processed with descriptive statistics for visualizing data-chart to have a better handle on the data (Befring 1994). Purposive sampling method was adopted to select the respondents to evaluate the condition of the facility environment on patients' outcome. According to Zikmund (2003), purposive sampling is "a

non- probability sampling technique in which a researcher selects the sample based on his/her judgment about some appropriate characteristics required of the sample members". The rationale for the selection was based on the premise that the selected respondents had stayed in the resident for quite a while, interacted with the spaces being evaluated and might otherwise have been affected by it.

Care givers such as officers, cooks and other stakeholders had their opinions sampled through personal conversations. Vital information's were gotten from this interaction which further assisted in the course of the research specifically for the checklist.

The observation schedule was designed by the researcher based on studying IAQ checklist manuals and observation schedule related to the sustainable design measures (Centre for Disease Control and Prevention 2005) according to the IAQ variables from literature. The first section of the observation schedule focuses to the property information, while the second section gathered information on the living information. The variables were analysed and scored based on the fieldwork results. Analysing these data involved relating each question on the schedule with the principles of IAQ.

Participants replied to a standardised questionnaire on sociodemographic factors, and health and potential risk factors with few open-ended questions, designed by the researcher in accordance the European Community Health Survey questions for respiratory health and related risk factors (Castejon-Cervero MA, 2011). Overall, 15 questionnaires were administered to participants (aged 65–80 years). The structured questionnaires were used to deduce the rating of user's satisfaction on the variable. The demographic characteristics of the participants of the survey are shown in Table 1.

Table 1: The Demographic characteristics of study population

Characteristics	**N =15**
Gender	11
Female	3
Age	
65-69	3
70-74	7
75-79	3
80-84	2
85+	0
Marital status	
Married	11
Widowed	4
Divorced	0
Others	0
Time of residence	
Less than 1 year	0
Between 1 and 5 years	5
More than 5 years	10

Source: Fieldwork (2019)

4.0. RESULTS AND DISCUSSION

In this section, first the scores of the different parts of older adult's apartment in old people's home (based on the checklist analysis) are reported, and second, the results of the survey are described. The survey analysis evaluates the resident's indoor air quality based on their perceived health symptoms and the building design as in the literature.

4.1. Design Considerations/Variables for Indoor Air Quality in the Residential facility.
The various ways in which these considerations can be experienced in the facility are natural lighting interiors spaces, natural ventilation in interior spaces, shading devices and a therapeutic environment.

4.1.1 Natural lighting in interiors spaces
In the facility visited, various types of natural lighting media were available. Windows and courtyard were the most common media. Figure 4.2 gives an illustration of the most common media used for admitting light to the interior spaces.

4.2.2 Natural ventilation in interiors spaces of hospitals
The relevance of natural ventilation in the senior's apartment spaces is seen in provision of indoor thermal comfort and a decrease energy consumption of air condition devices in the buildings. The window and courtyard admits air into the building. Figure 4.2 highlights the media of natural ventilation in a chart form.

Plate I & II: Courtyard (*right*) and window (*left*) as medium for lightning and ventilation.

The windows are cross ventilated with sizes, 1800 x 1500 mm in the bedrooms and 1800 x 2400mm in the Lounge. Air vents and clerestory windows are not used as they are not very common in Nigeria as seen from previous studies.

Shading devices:
The type of shading devices in the facility were vertical fins anchored to the skin of the building obstructing direct sunlight and glare.

Plate III: Vertical fins serving as shading device

4.2.4 Landscape and biodiversity.
Biodiversity is the combination of varieties of species whether plant or animal on land and water to form an assorted environment which helps in balancing atmospheric gases, water quality, provision of variety of fruits, provision of spices and herbs to aid the healing process.

i. Outdoor landscaping.
Observation shows that biodiversity and landscape configuration were not put into proper consideration in the planning of the facility as seen in plate IV&V, only trees as the biodiversity

component of the environment was found. Therefore, it is very relevant to integrate biodiversity and landscape configuration in the facility for the purification and filtration of the environs, releasing moistures and preventing dryness, to curtail stress and depression to the elders, decrease pain, boost up patient contentment and in addition to improve staff work productivity.

Plate IV & V: Trees provided as the only landscape element on the outdoor of the building
Source: Fieldwork (2019)

ii. Indoor landscaping: Indoor landscape plays a very important role in communicating the relevance of indoor air quality, they are achieved when natural elements such as plants, water, reliefs and geological formations are incorporated in the indoor spaces of a residential premises. Indoor landscape stimulates good emotions and instigates a pleasant psychological state of mind. Stress reduction and progress in clinical outcomes emphasises its relevance in the residence for the elderly. In the facility visited, there are no measures for indoor landscape.

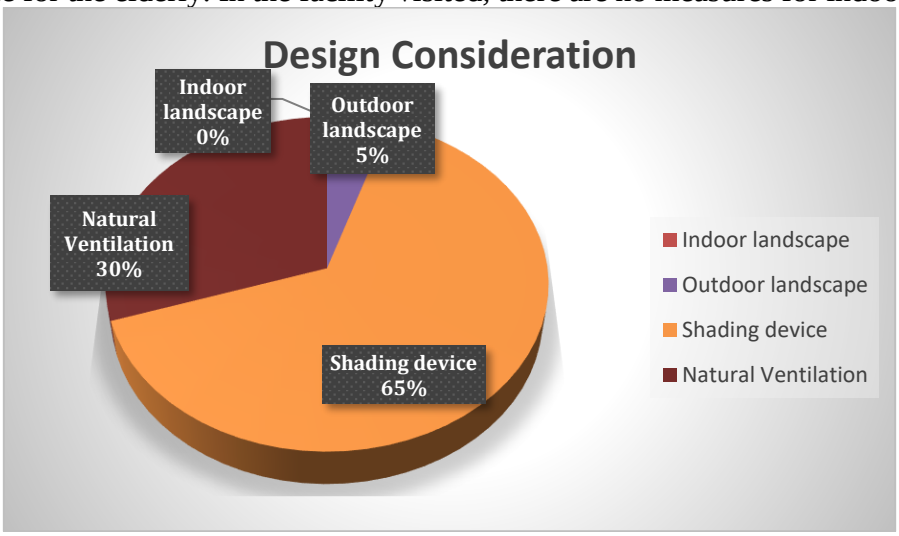

Figure 4.2.4: Design Consideration for Indoor air quality
Source: Fieldwork (2014)

4.2. Respiratory Symptoms

Household Characteristics and Occupant Activities were associated with Respiratory Health among the senior adult in the study. According to the Poisson regression analysis, to have higher prevalence of cough, running nose, allergies, wheeze, shortness of breath and chest pain. House characteristics that made a significant contribution to these respiratory symptoms included biomass fuel, cooking, source of lighting, floor and wall coverings.

Respiratory health among Seniors: Senior participants reported at least one respiratory symptom and the most common respiratory symptom was cough (40%), followed by runny

nose (20%), chest pain (10%), skin allergies (10%) and other symptoms (15%), there were no report of wheeze (Table 3).

Table 2: Housing Design

CHARACTERISTICS	TYPE
Number of rooms	36
Number of Residents	21
Smoking/Alcohol	-
Floor material	Concrete
Wall material	Block
Roof material	POP
Kitchen location	Outside
Source of Electricity	Electricity

Source: Fieldwork (2019)

Table 3: Respiratory symptoms

CLASSIFICATION	RESPONDENTS (%)
Respiratory symptoms	
Cough	40
Runny nose	20
Chest pain	10
Skin irritation	10
Other Symptoms	15
No Symptoms	5

Source: Fieldwork (2019)

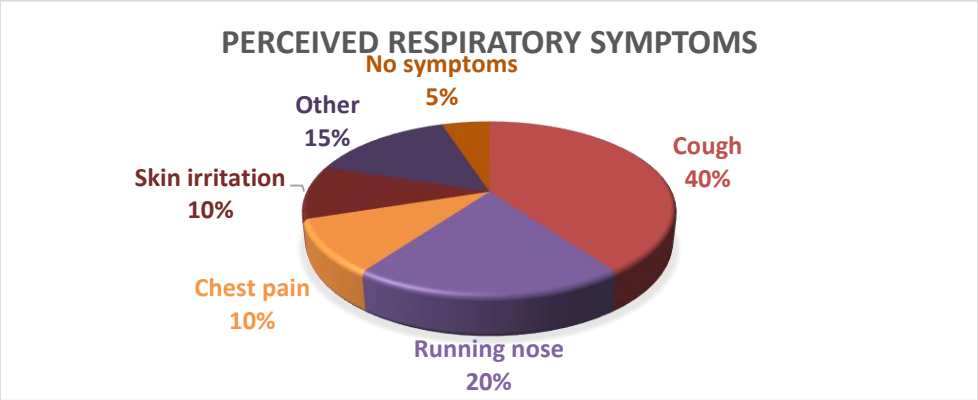

Figure 4.2: Perceived respiratory symptoms
Source: Fieldwork (2019)

5.0. CONCLUSION/ RECOMMENDATION

The study demonstrates association between certain building characteristics (i.e. the building orientation, wall and floor materials, housing type and number of rooms) as potential risk factors for certain diseases. It suggests that the state and condition of the geriatric facility as regards indoor air quality is generally not satisfactory. This is due to a significantly low level of attention paid toward organic IAQ design consideration, basically, lighting therapeutic views, biodiversity and landscape element. It is therefore important that government through the management of facilities for geriatric care, provide space with adequate integration of natural elements in and around the environment, to meet the aspirations of the users because the nature of environment a patient is exposed is expected to have an effect on the prevention of illness and aid recovery process. Intervention studies have proved that poor indoor air quality for the elderly can be improved significantly by using different strategies; including,

- Improved ventilation such as installing chimneys and smoke hoods
- Enlarged windows (Awning windows) should be used as a window type, 1800mm x 1800mm should be adopted as a minimum standard for window design.
- Landscape configurations should be in existence. Such as healing gardens, therapeutic gardens, viewing gardens, edible gardens, roof garden, vertical gardens and indoor plant as in reviewed literatures.
- Horizontal and vertical fins should be well design as part of the building form to serve as shading devices.

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Nexus between Social Infrastructure and Residents Wellbeing: A Review

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Abstract
Social infrastructure refers to various neighborhood facilities and services which improve cohesion and participation among residents to create a livable environment. Infrastructure is crucial to the development of a vibrant city. However, it is a requisite tool for human and social capital development, as it provides response to the basic needs of individuals and the community at large. Although social infrastructure is provided at various levels, the provision at neighborhood and urban centre's affect the wellbeing of residents and improve community sustainability. Despite several inputs by different authors on this subject, little have been said about the link between social infrastructure and wellbeing of residents at the urban centre's. Hence, this paper attempt to explore literature on the nexus between social infrastructure and resident's wellbeing. The study was achieved through systematic and random review of recent and relevant literatures on social infrastructure, quality of life and wellbeing. Also theories and concept of individualism, collectivism and cognitive psychology were highlighted. The review has observed that the role of social infrastructures play on residents wellbeing cannot be over thrashed. Therefore, it is necessary for development policies in the urban place to be in tone with best global practices, geared towards improving the living standards of residents by providing an enabling environment for individual capacity building and collective social development in order to improve resident's wellbeing.

Keywords*: Infrastructures, Livability, Sustainability, Wellbeing and Development*

INTRODUCTION

Social infrastructure services can be referred to as various services such as (education, medical, postal services, personal security, transport, communication etc.) which are provided mostly by the public sector to ensure that the living standards of residents are improved (Vaznonien and Kiausiene, 2018). Recent statistics have indicated that globally, cities are currently home to the majority of the world's population, an estimated one billion people are living in slums according to UN secretary- General on SDG progress report (2019) and he stressed that swift action is necessary to reverse the current situation.

Urban center's in Africa has become one of the fastest-growing regions of the world and rapid expansion is mostly hinged on the output of rural urban migration due to aspirations for life satisfactions, well-being and quality living (Satterthwaite, 2017). However, in sub Saharan Africa, the rate of urbanization growth and infrastructure inequalities has attracted global attention (Abubakar, 2010).

Rees *et al*. (2010) in their discussion argued that wellbeing gives relatively broad illustration of the living standard of the population and comprises both concepts, measuring the subjective satisfaction of the people which involves happiness, relations within families, with allies and colleagues. More so, it has to do with access to basic amenities within the residents and a situation where this is lacking it results to a situation of ill-being, a situation where people are experiencing low wellbeing or a state of deprivation (Rojas, 201 4). Furthermore, Abuja is now the fourth prime urban region in Nigeria after Lagos, Kano and Ibadan. The city's rapid rate of urban development is more shocking in its satellite towns, which are rising at close to 20% per annum. There is no doubt that the available infrastructures there have been overstretched as a result of this expansion (Abubakar and Doan (2010).

The ultimate objective of the sustainable development goals (SDGs) is to end poverty in all its forms everywhere so as to improve wellbeing and standard of living (SDGs, 2016). The idea of sustainable development is the kind of development that caters for the needs of the present generation without compromising the ability of the future generation to meet their own needs and aspirations (WCED, 1983). Lately, many researchers have conducted studies on urban problems that has to do with human wellbeing and sustainability and this is in line with the

United Nations (UN) sustainable development goals which include poverty reduction, zero hunger, good health, wellbeing, quality education, access to clean water, sanitation and others (UNDP, 2011). This study is a review of literatures on the nexus between social infrastructures and resident's well-being in the urban place.

Conceptual Framework

The conceptualization of wellbeing revolves round two schools of thought namely; the objective perspective which originates from the Scandinavian welfare research tradition and the subjective perspective which was derived from, and prevails in, the American quality of life research tradition (Susanne and Schwanen, 2013). The subjective idea believes that an individual's opinions and experiences are the basis for assessments of how well he or she lives. Alternatively, Gasper (2014) opined that the act of feeling and thinking, becoming and living and dying, and more, constitute a being. Therefore, he stressed that well-being thus has diverse aspects rather than set up a precisely delimited, narrow single notion of well-being, and then try to police its correct usage. He studied Wellbeing as an umbrella notion which comprise of the following ideas; Hedonism; well-being seen as pleasure, Desire theories; well-being seen as preference or desire fulfilment and Objective list theories of substantive conceptions.

In the objective view, well-being is established from the evaluation of the objective circumstances in which people live, given standards based on values, goals or objectives. Lately, the most influential objective indicator of social well-being is the United Nations Development Programme's (UNDP) Human Development Index (HDI). The HDI is a composite index that, since 1990, measures well-being by aggregating four objective indicators (life expectancy at birth; mean years of schooling; expected years of schooling; and gross national income per capita) across 3 dimensions—health; education; and living standards (UNDP 2011).

Social infrastructure services have increased over the recent decades, but due to the economic crises and demographic challenges, there has been a shift in understanding of how Social infrastructure services should serve people. Also, several scholars have explored the concept of wellbeing but the aim of this article is not to discuss the evolution of wellbeing. However, it is targeted towards the importance of infrastructure services to urban dwellers. Community wellbeing has to do with a community infrastructure that is accessible and available to all and supports the gathering of residents, healthy ecosystems that provide the region with valuable resources which support the sense of place (Vaznonien and Kiausiene, 2018).

Rojas, (2014) argued that well-being is conceptualized from the view point of the individualist culture which is seen as a living experience of being happy with oneself. People do experience well-being and they are in a privileged position to report what their situation is; it is for this reason that subjective well-being provides useful information about happy or satisfied people feel about their immediate environment. Hence, following a subjective well-being approach to poverty, Social infrastructure services could not only aim to abate poverty but they could also have targeted to raise people's well-being. Necessities of communities as well as prospects to satisfy them are one of the most important factors affecting the demand and supply of Social infrastructure services. Needs of communities being the social determinants of higher wellbeing could motivate, stimulate or limit Social infrastructure development (Atkociuniene et al, 2015).

Livability

Veenhoven (2014) defined livability as the degree to which a living environment fits the adaptive collection of a species practical to human society, it denotes the fit of institutional arrangements with human needs and capacities (Kaal 2011). According to Livability hinges

upon three key symbiotic domains of social life: the economy, social well-being and the environment. (Hart, 1998) The livability theory has the following assumptions

- Like all animals, humans have innate needs, such as for food, safety, and companionship.
- Gratification of needs manifests in hedonic experience.
- Hedonic experience determines how much we like the life we live (happiness). Hence, happiness depends on need gratification.
- Need gratification depends on both external living conditions and inner abilities to use these. Hence, bad living conditions will reduce happiness, in particular when its demands exceed human capabilities.
- Societies are systems for meeting human needs, but not all societies do that job equally well. Consequently, people are not equally happy in all societies.
- Improvement of the fit between social institutions and human needs will result in greater happiness.

Sustainability

The concept of sustainability is a relatively new idea, the movement as a whole originates from social justice, conservationism, internationalism and other past movements with rich histories (WCED, 1983). the end of the twentieth centuries, many of these ideas had come together in the call for 'sustainable development.'

According to UN (2003) The United Nations trapped former Norwegian prime minister Gro Harlem Brundtland to run the new *World Commission on Environment and Development*. In 1983 after decades of struggle to raise living standards through industrialization, many countries were still dealing with life-threatening poverty. According to Seghezzo (2009) The reports from the world conference on environment and development in 1987 led to further review of the concept of sustainable development which propose a sustainability triangle formed by 'Place, Permanence and Persons

Development

Sen, Amartya (1989), in his discussion on development and capabilities consider first an approach to development, in which the objective is to attain and withstand high rates of economic growth. The irresistible priority is economic growth. Here, the unit of analysis is obvious: the economy. The currency of evaluation is clearly monetary income. Trade-offs, such as between environment protection and employment creation, are in many cases resolved by market prices and exchange rates. He further stated that another approach to development in which the objective is to enlarge what people are able to do and be, what might be called, people's real freedoms.

It is people centered. In this view, a healthy economy is one which enables people to enjoy a long healthy life, a good education, a meaningful job, family life, democratic debate, and so on. Nevertheless, the success of all this has to be judged ultimately in terms of what it does to the lives of human beings. The enhancement of living conditions must clearly be an essential if not the essential object of the entire economic exercise and that enhancement is an integral part of the concept of development (Bauer, 1971)

The UNDP (1990) first report on human development have pursued the idea of bringing the human development perspective to the front burner on a range of issues. Also, lately different entities are producing their own National and Regional Human Development Reports in addition to the global report and some countries have state or provincial reports. These reports are intended to assess the state of a population from the perspective of people's lives and their analyses draw on data regarding people's health, education, political freedoms, security, environment and other aspects of their lives (Alkire, 2002). Through assessing the state of a

population from a human development perspective, these reports have the political purpose to raise awareness and generate public debate regarding public issues and concerns which would not have been considered in the political agenda for implementation.

Social infrastructures and resident's well-being

The wellbeing of urban dwellers revolves within several systems of social infrastructural facilities that are available and accessible to them. The environment and health are main areas (apart from financial situation, job, leisure, and housing) that constitutes the concept of subjective well-being referring to how people experience the quality of their lives based on their emotional reactions and cognitive judgments (Joanna, 2018)

Transport provides the basic conditions for active functioning of national economy and society; it is an important tool of achieving social, economic, foreign-policy goals. Transport has become the principal tool for achieving the national goals (Popova, 2017). Simultaneously, transport system can be a bottleneck of any economy, since the problems of transportation system facilitate the infrastructural restrictions and create the threat of deceleration of social development of the country. Most often that Social infrastructure which forms a system of social support and one can say that the communities aiming to satisfy the social demands create conditions for constant, continuing social evolution and reduces the feeling of helplessness of people when they come across problems which are abundant in the life of both a separate person and various communities (family, team, nation etc.) as well.

"If we are to have any chance of creating vibrant new communities that offer residents quality of life and that open up new opportunities – communities that are well balanced, integrated, sustainable and well connected – then we have to think about building for the wider needs of the whole community, not just focus on building homes." (Emily et al, 2005) as cited in (Dette and Gartner, 1987)

According to Dette and Gartner (1987) the lack of social infrastructure to support new residents when they arrive slows the process of building a community and can create long-term problems for the wellbeing and opportunities of new arrivals. New communities need provision of space for support services first even before the development of buildings this article stressed the need of the idea of 'walking distance communities' where each neighborhood have each of the following; chemist, church, public community Centre and sports facilities.

Measuring Wellbeing

There is a wide acceptance of the fact that measurement of well-being can be considered using two broad approaches: objective and subjective measures. Hence, the both approaches are necessary. Objective measures make assumptions about what is required for any individual and then sets out indicators to estimate how far the requirements have been satisfied. Also, according to Selwyn and Riley (2015) the objective indicators usually measure three main areas namely; Economic, Quality of life and Environment. More so, objective measures on their own cannot measure a nation's progress completely and that subjective measures are also needed.

The subjective well-being approach understands well-being as the experience people have in their living conditions. Well-being is, in consequence, something that happens in the realm of the person and not in the realm of objects. Objects and factors may be of relevance in generating well-being, but they are not well-being (Rojas,2014). Hence, Subjective measures usually sample people's opinion to assess their own well-being. There are three broad approaches (the evaluative, experience and eudemonic) to measure subjective well-being. According to King et al., (2014) in his study acknowledged that subjective measurement tools focuses on individual reports of life experiences that complement social, economic and health indicators considering the extent to which ones perceived needs are met and the importance of that perceived need which has resulted to a major methodological flaws. It has been observed that

no single indicator can measure well-being across all the disciplines. Participatory methods and mixed methods approaches have provided valuable insights into how local people define well-being, and as Camfield et al. (2009)
note, ''*The contribution of qualitative approaches to a focus on people's resources and agency is that they can encompass areas of people's lives that are influential and important, but rarely measured"*
Various methods have been used to scale, normalize, weight and aggregate wellbeing and sustainable development indices and much disagreement has sprouted regarding how to normalize the scores for the different criteria included to make them comparable (in terms of units and importance), and how to aggregate the standardized scores into an index (Bo ¨hringer and Jochem 2006).

Access to social infrastructures and resident's wellbeing

The role of social Infrastructure services and physical planning in the development and establishment of sustainable cities cannot be over emphasized. This is because every plan must have spaces reserved for the location of infrastructures which will make the community livable and conducive. Residence wellbeing have several links with spatial variables especially in our immediate environment, the socio-economic and physical development of any geographical entity is a function of the investment in quality infrastructures (Sapkota, 2018). The World Bank in 2007 noted that the Organization for Economic Co-operation and Development (OECD) estimates that total global expenditures on infrastructure in energy, transportation, and water from 2000 to 2030 will need to be about $57 trillion (in constant 2000 US$) in order to attain targeted economic growth rates. About half of this spending will be in emerging economies, which have the greatest needs for additional infrastructures. Some of the arguments on wellbeing and infrastructure both locally and globally are as follows; (Eja et al., (2011), Bai, et al., (2012), Popova, (2017) Sapkota, 2018; Roy et al., 2018; Rigon, 2018) among others.
Eja et al (2011) conducted a study in port Harcourt on access to urban water supply and it was observed that water supply is a serious problem which result to people travelling long distance often on foot to get water for domestic use. This situation has often led children roam the street in search of water and deprive them of the opportunity to go to school and it has affected the well-being of the residents. Also, according to the Stockholm environmental institution, one-third of the world's population already live in areas that suffer moderate to severe water shortages. The World Health Organization (WHO), noted that majority of people in new urban centers of developing countries do not have access to portable water, which is considered in developed countries to be a basic necessity (WHO, 1997). However, this research work does not state clearly the proportion of respondents that were captured within each zone of study this can affect the fair representation of the entire study area.
Bai, et al., (2012) Conducted a study on health and well-being in the changing urban environment and they observed that Urban poor communities are extremely exposed to health risks due to the deficiency of proper infrastructure, poor access to health care, information and knowledge networks. Such inequalities are not exclusive to, but more prominent in, developing cities, suggesting a universal need for better urban management and governance with the use of system approach to achieve equitable health and wellbeing outcomes. Furthermore, studies of Popova, (2017) examined the factors of population wellbeing and the relations with transport infrastructure development of Latvia around the Baltic States and he argued that transport infrastructure contributes immensely to people's well-being. However, the study was limited to transportation infrastructure alone and indicators of wellbeing investigated in this research are level of poverty of population and level disposable income of households per capita.

Other indicators of well-being such as health, environmental quality and education were left out. Therefore, there is need to explore further in research to increase the area scope. Another study conducted by Sapkota, (2018) on the access to infrastructure and human wellbeing evidence from rural Nepal documents the level of access to infrastructures and assess its perceived impacts on human well-being in less remote communities and observed that the perceived impacts of access to infrastructure on human wellbeing is higher in more remote areas.

The study's outcome can be useful in similar areas in Nepal and, to a certain extent, in other parts of the world. More so, this study is applicable for choosing the best rural infrastructure projects in hilly and mountainous rural areas. However, the findings can provide only a reasonable reference to similar areas and establish a causal relationship between the level of access to different types of infrastructures on different aspects of human well-being, we suggest further research using larger samples. Also, in the method of selecting the samples only remote communities were picked it was not done randomly. The study concentrated on rural areas alone, what is the likely scenario of the urban place? More so, the survey was aligned to the living standard of Nepal as a result of the method of data collection and analysis that was adopted. Hence results from the studies will not be applicable elsewhere.

Rigon (2018) carried out an investigation on the analysis of wellbeing in urban Nigeria, by selecting some elite stakeholders in the urban sphere and sampling their opinions and the analysis revealed that there is need for underpinning urban policies with regards to human well-being. This study identified several approaches to understanding the concept of well-being such as; objective, hedonic, evaluative account, preference satisfaction, capability and functioning and he assumed that most of the approaches have some characteristics in common. Though he based his arguments on what different stakeholders have perceived well-being to be. The method and sampling procedure employed for this study does not have a fair representation of all the intended beneficiaries of the research findings.

Manggat et al (2018) carried out a research on the impact of infrastructure on rural communities in Malaysia they gathered that rapid growth in the rural economies is determined by the accessibility and the delivery of essential infrastructures and the impact of the infrastructure development is also related to the quality of social services especially in the aspect of education, health and the quality of life of rural communities in general. However, they observed that the provision of sufficient and efficient basic infrastructure is the basis of a good quality of life among rural communities. Nevertheless, this review focused on the rural areas alone without considering the urban and peri-urban areas that experience the same challenges as a result of urbanization.

Melanie et al (2017) carried out a study using spatial measures to test a conceptual model of social infrastructure that supports health and wellbeing tested a limited number of pathways in a new conceptual framework of social infrastructure and found preliminary support for associations between social infrastructure and SWB. The research opined that accessibility to a range of social infrastructure services promoted the SWB of residents. The conceptual framework was tested using spatial neighborhood attributes and regularly collected population health survey data to demonstrate the importance of both access, and mix of social infrastructure services as upstream health determinants and their influence on downstream health outcomes.

The study further noted that people had spatial access to SI services within 800 m and others with access nearly doubled at 1600m. Hence, having access to single services at 1600m was not most beneficial to health and results suggested that the mix of social infrastructure services available within 800m was most beneficial to residence well-being. Nevertheless, this research considered only the health outcomes without looking at other factors that constitute wellbeing.

Also, applicability of social infrastructure services and facilities to different demographic groups to assess their relative influence on health and wellbeing was not explicit enough. The issue of service quality, service capacity and delivery was not considered appropriately.

Ikenna (2016) discussed the access to social infrastructure in contrast to availability in rural areas of Imo State. The study used Questionnaire survey method and oral interviews to gather data on identified indices of accessibility to social infrastructure, income or affordability. Also, three variables of social infrastructure were used in this study; health care facilities, schools and leisure centers. The result shows a strong positive relationship between income and access to social infrastructure in the pilot area. However, this research was carried out in rural areas of Imo state, the basis for selection of those pilot areas were not explicit enough and the sampling procedure for the sample frame was not clearly stated. It did not explain how the house hold heads will be sampled whether randomly or systematically and the proportion of respondents per area was not determined in the study. Furthermore, the second objective which is to ascertain the conditions of social infrastructure in the study area was not properly captured in sources of data. There was no check list to examine the state functionality or physical co nditions.

Improving the quality of life has been a subject of discussion by various researchers in the past but the aspect of defining what the quality of life entails and measuring progress has not been properly captured in literature (Costanza et al, 2006) in his study an approach integrating opportunities, human needs and subjective well-being. He concentrated on the definition of the indicators of quality of life from different disciplines with respect to measurement of human needs with objective and subjective well-being approaches. Therefore, integrating these two concepts in the research was able to overcome the issue of bias and it gives a clearer picture of QOL in both multiple spatial and temporal scales. Hence quality of life was defined as the extent to which human needs are met in relation to individual or group perceptions of subjective well-being. Also this study provides a foundational insight needed to make an integrative QOL tool more robust and applicable across temporal, cultural and spatial scales for resolving the issue of scale and weighting of variables.

Despite the contribution of all these studies much has not been said about the urban infrastructure provisions and resident's satisfaction locally especially in Nigeria with its fast growing urban Centre's. Abuja is among the sub-Saharan African cities experiencing series of urban infrastructural deficit as a result of its rapid urban population growth without urban governance structures in place that can meet their challenges and manage the changes (Satterthwaite, 2016). It has been named among the fragile cities in West Africa because municipal authorities and their institutions are unable or unwilling to provide basic services to urban residence (Muggah, 2016). Hence this study identified the following gaps in existing literatures; insufficient local data on the subjective and objective measurement of residents wellbeing, especially at the neighborhood level and Urban place with respect to access to infrastructure provisions, satisfaction with living environment and overall quality of life which will provide useful data to policy makers for inclusive planning procedure, project implementation by Non-governmental organizations and other international development partners.

CONCLUSION AND THE WAY FORWARD

The relevance of infrastructure provisions to resident's satisfaction cannot be overemphasized in the quest to achieve sustainable development goals. Also, it is necessary for development policies in the urban place to be in tone with best global practices in the world in order to improve it ranking among contemporary global cities. Therefore, it is against this background that this study decides to carry out an analysis on urban infrastructure and residents wellbeing

in the urban space with the view of opening new areas of research, fill existing gaps identified in literature so as to provide the basis for proper implementation of policies and plans that will create a conducive environment for living and working for urban residence.

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Impact of the Land Use Act on Sustainable Housing Development in Nigeria from 1978-2018

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Abstract:
The Land Use Act ('the Act') was enacted to address the problems associated with acquisition of land for development purposes such as housing development. However, since the inception of the Act about 42 years ago, the objective of sustainable housing development in Nigeria has not been realized as majority of Nigerians cannot afford decent housing. The research problem lies in the inability of the Act to facilitate housing development and delivery in Nigeria which can be traced to requirement of consent of Governor, the power of revocation of land for public purpose, and entrenchment of the Act in the constitution. The objective of this paper is therefore to examine the legal effects of these provisions on housing development. This paper employs the doctrinal method of research by reliance on legislation, case laws, textbooks and journal articles to examine the impact of the Act on housing development in Nigeria. The finding of this paper reveals that the requirement of Governor's consent and exercise of power of revocation are serious impediments to access to land for housing. More so, the entrenchment of the Act in the Constitution made it difficult, if not impossible, to amend the Act. It is thus recommended that the Act should be amended to make the processes of revocation of land by government and obtaining consent of the Governor less cumbersome. Finally, the constitution should be amended to expunge the Act from the Constitution to make it easy for Act to be amended to fastrack the development in the housing industry.

Keywords*: Land, Housing, development, Constitution,*

INTRODUCTION

The significance of land to any society cannot be over-emphasized due to the fact that every development has to be carried out on land. Access to land is an indispensable factor to be reckoned with in a capital intensive investment such as provision of mass housing to Nigerians by government.[56] For housing purposes, land is an indispensable factor in any plan to provide houses to the citizens or to provide financial assistance to those who want to build and own their own houses. In Nigeria, government is under a social contract to ensure that Nigerians have equal access to property and property rights, and to direct its policy towards ensuring that suitable and adequate shelter is provided for all Nigerians.[57]

However, there has been shortage of low-cost housing units in Nigeria which has pushed many Nigerians including the working class to the slum areas. Nigeria is currently faced with a housing deficit of about 17 million units, and thus requires an additional one million housing units per annum for the next eight years to reduce the deficit.[58] Umezulike (2016) submitted

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[56] Dimuna,K.O. (2016) Enhancing Land Acquisition for Individual Housing Development in Nigeria: A Case Study of

Benin Metropolis Edo State, Nigeria. International Journal of Research and Innovation in Applied Science (IJRIAS),

Vol.1, Issue VII, p.1.

[57] Section 16(2)(d) of the Constitution of the Federal Republic of Nigeria (1999) as amended.

[58] Umezulike, I.A. (2016) The Land Use Act-A Catholic Legislation? In: Utuama, A.A. (ed.) Critical Issues in Nigerian

that the Land Use Act[59] (hereinafter referred to as 'the Act') has sufficiently addressed the issues of planning, development and control of land in Nigeria as a springboard to mass housing delivery in Nigeria.[60] This submission of the learned author seems to suggest that the Act has achieved the objectives for which it was enacted, and that the problem of inadequate housing in Nigeria lies outside the Act. However, this research is driven by the position that the problem of inadequate housing in Nigeria lies within the Act.

The basic philosophy of the Act is to make land available to all Nigerians and to preserve the right to land.[61] The Act sets out a legal framework for a national land policy, and it represented a shift from the colonially inspired laissez faire policy of 'dualism' in the Southern states, and in the Northern States, a modification of inherited policy of 'paternalism'; to one anchored on the "trusteeship" policy.[62] The trusteeship policy was intended to achieve certain objectives such as to secure for Nigerians the right to land for building, residential and commercial purposes. The policy also re-affirms that nobody in Nigeria apart from the state or federal government owns land, and power of management and control is vested in the Governor who is a trustee.[63]

The objective of Government towards providing housing for all as contained in the National Housing policy, which seeks to provide affordable housing for Nigerians, has not been achieved, even as the National Housing policy has become an illusion.[64] The research problem is based on the inability of the Act to address the problem of housing deficit in Nigeria arising from high cost of land, and lack of security of title to land. Thus, despite the existence of the Act for more than four decades, it has fallen short of realizing one of its fundamental objectives of making lands available to Nigerians for housing purposes. The geographical scope of the paper extends to the whole country because the Act has nation-wide application, and the problems associated with the Act which impact negatively on housing development in Nigeria are not restricted or peculiar to a particular zone or state. Hence, the need to examine the impact of the Act since its inception in 1978 to 2018, which marks four decades of the enactment of the Act. This paper employs doctrinal research methodology which is a purely theoretical research, and is concerned with analysis of the legislation and case laws and how they are applied.[65] The aim of this paper is to examine some aspects of the Act that inhibit and pose challenge to sustainable housing development in Nigeria, and the objective of the paper

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Property Law. Malthouse Press Ltd, Lagos, p.98.

[59] Cap. L5, Laws of the Federation of Nigeria,2004.

[60] Umezulike, I.A. Op. Cit.p.98.

[61] Utuama, A.A. (2002) Nigerian Law of Real Property. Malthouse Press Ltd, Lagos, Second Edition, p.263.

[62] James. R.W. (1982) Nigerian Land Use Act: Policy and Principles. University of Ife Press, Ltd , Ile-Ife, p.1

[63] Madaki, A.M. (2006) "The Land Use Act Policies: An Overview". Journal of Private and Comparative Law, Ahmadu

Bello University, Zaria, p. 86.

[64] Iheme,J.O. Et al. (2015) The Effect of Government Policy on Housing Delivery in Nigeria: A Case Study of

PortHarcourt Low Income Housing Programme. International Letters of Social and Humanistic Sciences, SciPress

Ltd, Switzerland, p.88.

[65] Ali,S.I Et al. (2017) Legal Research of Doctrinal and Non-Doctrinal. International Journal of Trend in Research and

Development, Vol.4(1),p.493.

therefore is to establish that the Act is partly responsible for the problems of housing development in Nigeria, and proffer solutions to these problems, and suggest how the Act can be used as a viable tool to revolutionalise the housing industry in Nigeria.

HISTORICAL BACKGROUND TO THE ACT

Before the arrival of the Europeans in Nigeria, every community in Nigeria had its own customary law through which land was acquired and managed. However, with the advent of the Europeans, series of allegations were made against customary law. The customary law was regarded as archaic and too primitive, and it did not guarantee security of title to land, and land was not alienable.[66] The difficulties associated with land acquisition for development project and individual ownership of land coupled with speculation in urban land were highlighted in the Third National Development Plan 1970-1980.[67] In urban areas, acquisition of land both for government projects and other building purposes became virtually impossible. Additionally, there was the problem of insecurity of title under customary law. The inability of the public and private sectors to provide sufficient shelter for the people, and even the inflationary trends in the economy were blamed largely on the system of tenure.[68]

The Anti-Inflation Task Force highlighted the need to avoid the injustice of private appropriation of socially created wealth, and to remove the bottle-neck that land constituted to development and, in particular, to the expansion of the housing programmes.[69] The Report recommended the promulgation of a legislation that would vest all lands in the state government. In 1977, the military government set up the Land Use Decree Panel which Report was never made public.[70] However, the Reports of the Land Use Decree Panel and the Anti-Inflation Task Force culminated into the promulgation of the Land Use Decree which was essentially based on the Land Tenure Law of 1962.[71]

SUSTAINABLE HOUSING DEVELOPMENT

The concept of sustainable housing is synonymous with sustainable growth. Sustainable housing development can be defined as the development and implementation of policies, programmes or initiatives designed to deliver safe, viable and affordable houses for individuals.[72] This concept adopts the tenets of sustainable social, economic and environmental factors in delivering national housing plans and policies for the masses with minimum impact on the environment. The importance of housing to man cannot be overemphasized. Good housing serves as a place where a person gets shelter, comfort, security and dignity among others.[73]

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[66] Aboki, Y. (2005) "The Land Use Act and Foreign Investment in Nigeria". Contemporary Issues in Nigerian Law.

Chukkol, K.S. et al. (eds.) Faculty of Law, A.B.U. Zaria,pp.5-6.

[67] Ibid.

[68] Olong, A.M.D. (2011) Land Law in Nigeria. Malthouse Press Ltd, Lagos, Second Edition, p.142.

[69] James, R.W. (1982) Nigerian Land Use Act: Policy and Principles. University of Ife Press Ltd,Ile-Ife,p.26.

[70] Ibid.

[71] Ibid.p.27; see also Olong, A.M.D. Op. Cit. p.143.

[72] Ojoko, E.O. (2016) Sustainable Housing Development in Nigeria: Prospects and Challenges. Journal of Multidisciplinary Engineering Science and Technology (JMESI). Vol.3, Issue 5, Available at https://www.researchgate.net>publication>304538510. Accessed on 8/09/2019 at 12:14am

[73] Aluko, O. (2012) "The Effects of Land Use Act on Sustainable Housing Provision in Nigeria: The Lagos State

The history of formal intervention into housing sector in Nigeria dates back to the colonial administration with the establishment of the Lagos Executive Development Board which was focused on the provision of expatriate quarters.[74] However, a robust housing policy was launched by the then military government in 1991 with the slogan 'Housing for all by the year 2000 A.D'. The goal of the policy was for all Nigerians to have access to decent housing at affordable cost before the year 2000.[75] This policy was rigorously pursued but it was besieged by administrative bottlenecks which made it difficult for the objective of the policy to be realized.[76] In 2002, the Housing and Urban Development Policy was formulated to correct inconsistencies of the Act as well as to allow land to be used in a free market economy.[77] The inability of previous policies to adequately resolve the backlog of housing problems in Nigeria reveals the need for more pragmatic solutions, and this forms the basis for a review of the 1991 National Housing Policy.[78] Given the importance of housing in the national economy, the federal government of Nigeria set up a 15- man committee on urban development and housing in 2001 with a responsibility to articulate a new housing policy.[79] The report of the committee as accepted by the federal government was published in government white paper on the report of the presidential committee on urban development and housing in the year 2002.[80]The report contains a new housing policy, which was subsequently published in the year 2006.[81]

Due to the failure of the previous policy, a committee was set up to review previous National Housing Policy, and a new National Housing Policy was adopted in 2012 with the following objectives: develop and sustain political will of governments for the provision of housing, develop an efficient land administrative system to enable land ownership available, accessible, secure and easily transferable at affordable price, and provide adequate and affordable housing finance to all Nigerians by developing efficient primary and secondary mortgage markets.[82] Additionally, the goal of sustainable housing development as contained in the Goal 11 of the United Nations (UN) 2030 Agenda for Sustainable Development is 'increased access to sufficient, safe, and low-cost housing' for the world's poorest people living in the slum areas.

Experience". *Journal of Sustainable Development*, Vol.5, No.1, p.117

[74] Bello, A. (2019) Review of the Housing Policies and Programmes in Nigeria. International Journal of Contemporary Research AND Review, Vol.10, Issue 2, p.10.

[75] Ibid.,p.11.

[76] Abraham, S.S. (2019) Assessment of National Housing Policy and Homelessness in Nigeria: Policy Options for Buhari's Administration. Journal of Humanities and Social Science, Vol.24, Issue 5, p.35.

[77] Ibid.

[78] Waziri, A.G. and Roosli, R. (2013) Housing Policies and Programmes in Nigeria: A review of the Concept and Implementation. Business Management Dynamics, Vol.3, No.2, p.64.

[79] Ibid.

[80] Ibid.

[81] Ibid.

[82] Ibid.

However, Nigeria is presently the most populous African country with the largest economy. The deplorable situation of housing in Nigeria has been captured thus:[83]

> …decent and adequate shelter is one of the basic needs of the individual, family and community. The house and the environment on which it stands also have profound influence on human health, efficiency, social behaviour and satisfaction. Therefore, the importance of providing adequate number of dwellings which contain essential utilities and services for community life and satisfies reasonable standards of comfort and hygiene cannot be overemphasized as shelter is basically acknowledged to have a profound impact on the lifestyle, health, growth, happiness and productivity of an individual. Therefore, lack of it is one of the worst forms of poverty. An overview of the housing sector in Nigeria clearly reveals that access to adequate and affordable housing remains elusive to many Nigerians both in the urban and rural areas.

The above statement summarizes the importance of housing to the individual and the community, and how decent accommodation or shelter affects the social and economic life of the individual and society. Nigeria is one of the poorest countries of the world with majority of the population living below poverty line. The implication is that only few Nigerians can afford to buy land to build their houses. In Lagos, Ibadan, Kano, and Abuja, the need for housing is rising by about 20 percent a year as current total output in the formal housing sector is estimated at no more than 100,000 units.[84] While no adequate data available, it is clear that the formal sector is only producing a fraction of the total number of urban units needed each year.[85] The UN estimates that by 2050, 75 percent of the population will be living in cities.[86] This translates into an annual housing requirement over the coming decades of at least 700,000 units just to keep up with growing population.[87]

IMPACT OF THE ACT ON SUSTAINABLE HOUSING DEVELOPMENT

There are some provisions of the Act which have created problems that militate against housing development in Nigeria thereby accounting for the slow pace of growth and development in the housing sector. It may be argued that the Act has addressed all issues relating to planning, development and control of land in Nigeria, and therefore government has no major obstacle in the acquisition of land for mass-housing delivery to the citizens. However, the World Bank report shows that changes to the land and legal framework can help to speed development of the housing and mortgage sectors.[88]Thus, the objective here is to highlight those aspects of the Act that constitute a clog in the wheel of sustainable housing development in Nigeria.

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[83] Chinwuba, N.N. (2016) Concept and Conception of Property in Law: The Link with Shelter in Nigeria. In: Utuama, A.A. (ed). Critical Issues in Nigerian Property Law. Malthouse Press Ltd, Lagos, p.25.

[84] (2016) Nigeria: Developing Housing Finance. World Bank. Available online at: http://documents.worldbank.org/curated/en/102491481528326920/pdf/110897-WP-P131973-PUBLIC-HousingFinanceNigeriaweb.pdf. Accessed on 1/4/2020 at 10:15am.

[85] Ibid.

[86] Ibid.

[87] Ibid.

[88] Ibid.

Consent Requirement under the Act

The provision that the consent of the Governor must be obtained before any transfer of right over land can be effected is perhaps the most potent provision of the Act which enhances security of title.[89] The implementation of the consent provision has placed severe bottlenecks in the path of those willing to acquire or transfer land for residential, industrial or commercial purposes thereby impeding housing development in the country. Section 22 (1) of the Act provides that it shall not be lawful for the holder of a statutory right of occupancy granted by the Governor to alienate his right of occupancy, or any part thereof by assignment, mortgage, transfer of possession, sub-lease or otherwise howsoever, without the consent of the Governor first had and obtained.

Thus, the Act forbids alienation of rights of occupancy in any manner without the requisite consent, while section 26 of the same Act says that any alienation without the consent shall be null and void. The same restraint applies to the holder of customary right of occupancy and statutory right of occupancy.[90]Thus, in *Brossett Manufacturing Nig. Ltd v. M/S Ola Ilemobola Ltd*,[91] the Supreme Court held that any alienation without the Governor's consent is null and void. In *Savannah Bank of Nigeria v. Ajilo*,[92] the Supreme Court decided that all transactions under which an interest in land is transferred requires consent for its validity otherwise it is void. As rightly observed by prof. Sagay, as a result of this decision of the Supreme Court, Savannah Bank was unable to realize the primary purpose of mortgage in this case i.e. sale of the property as a consequence of default on the part of the mortgagor. He further noted that this case sent alarm bells ringing in many banks because of the possible abuse and exploitation to which the principle could be put by unscrupulous debtors; indeed there was a danger that banks' lending activities would be stalled with the attendant effect on economic activities.[93]

Luckily the Supreme Court seems to have realized its error because in subsequent cases of *Awojugbagbe Light Ind. Ltd v. Chinukwe*[94], and *Attorney General of the Federation v. Sode*[95], it held that in land transactions, the holder of the right of occupancy is the person to obtain the governor's consent as well as to register the deed in the Land Registry.[96] The position of the law now that failure to obtain consent does not render the transaction a nullity is more inclined to doing substantial justice rather than adhering to mere technicality. The implementation of the consent provision of the Act has placed severe bottlenecks in the path of those willing to acquire or transfer land for industrial or residential purpose. The problem has been summarized thus:[97]

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[89] Taiwo. E.O. (2005) "Interpretation and Constitution of the Phrase 'Consent First hand and Obtained' under Section 22 of the Land Use Act, 1978". *University of Ibadan Journal of Private and Business Law*, Vol.4, p.79

[90] FARMERS SUPPLY COM KDS V. MOHAMMED (2009) LPELR, pp.26-27,paras.D-B)

[91] (2007) LPELR-809

[92] (1989) 1 NWLR p.305.

[93] Sagay, I.E. (2000) Nigerian Law of Contract. Spectrum Books Limited, Ibadan, pp.376-377

[94] (1993) 1 NWLR (270) p.485 at 512

[95] (1990) 1 NWLR (p.128) p.500

[96] Sagay, I.E. Op. Cit, p.377

[97] Ogiji, L.O. (2015) The Land Use Act and the Challenges of Restraints in Transfer of Land Rights. Ahmadu Bello University Law Journal, Vol.29-35, p.2.

> The operations of the consent provisions of the Act have made land transaction more difficult and less economic. In fact, it can be said that the delay in seeking compliance with the consent provisions of the Act has tended to reduce considerably the number of land transaction; consequently, capital formation has not been satisfactory, so also is the general development process in the country.

Furthermore, the practice of demanding exorbitant consent fees by some states has been a source of great dissatisfaction.[98]There is no legal basis for charging consent fees. This constitutes serious impediment to access to land, and poses great challenge/difficulty in land/property transactions in Nigeria, thus making alienation of land as difficult as it was before the enactment of the Act.[99] Apart from the exorbitant nature of the fees charged for consent, it has also been stated that the government uses the opportunity to collect withholding tax, capital gains tax and stamp duties which increase the cost of accessing land, thereby making it difficult to alienate it.[100]There is thus a serious constraint on someone who is desirous to sell or buy a piece of land for housing purpose as a result of the high cost of land. The effect of the consent requirement was summarized as follows: "it is bound to have a suffocating effect on the commercial life of the land and house owning class of the society who use their properties to raise loans and advances from banks…these areas of the Land Use Act need urgent review to remove their problem nature."[101] Thus, the requirement that consent of the Governor must be obtained has a negative impact on the housing development in Nigeria. Any provision of the law that restricts alienation of land will definitely affect sustainable housing development.

Entrenchment of the Act in the Constitution

The Act was very unpopular at its inception and there were threats by some politicians during the 1978 political campaigns to abrogate it.[102] This informed the decision to incorporate the Act into the constitution to prevent untimely abrogation of the legislation. However, the relationship between the Act and the constitution has generated controversies. This made Olanipekun (2016) to submit that the entrenchment of the Act in the constitution is a constitutional absurdity.[103] The provision of section 315(5) of the Constitution provides that the provision of the Act can only be amended in accordance with section 9(2) of the constitution. The result is that the procedure for amendment of the Act is the same as the procedure for amendment of the constitution, however stringent it is.

Section 315(6) of the Constitution also provides that the Act shall be regarded as one of the items in the Exclusive Legislative List. However, unfortunately, most lands in the country are

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[98] Ibid, p.3.

[99] Ibid.

[100] Ibid.

[101] Banire, M. (2016) Administration of Consent Provision under the Land Use Act: a Curse of Blessing for Development- Case Study of Lagos State. In: Utuama, A.A. (ed.). Critical Issues in Nigerian Property Law. Malthouse Press Ltd, Lagos, p.115

[102] Olong, A.M.D. (2011) Land Law in Nigeria. Malthouse Press Ltd, Second Edition, p.144

[103] Olanipekun, W. (2016) Constitutionality of an Unconstitutional Act: The Unconstitutional Entrenchment of the Land Use Act in the Nigerian Constitution. In: Utuama, A.A. (ed.) Critical Issues on Nigerian Property Law. Malthouse Press Ltd, pp.164-165.

under the control of the state government. Therefore what is the rationale for considering the Act as one of the items in the Exclusive Legislative List? The entrenchment of the Act in the constitution appears to have elevated the Act beyond the level of ordinary legislations thereby making it impossible to amend.[104] It will appear that every attempt to revolutionalise the housing industry in Nigeria must start from the genesis of the problem i.e. the incorporation of the Act in the constitution.

The present constitutional arrangement is not in the best socio-economic interest of property rights of Nigerians, as the entrenchment of the Act in the Constitution has frozen the principles of the Right of Occupancy and property rights.[105] More so, to amend the provisions of the Act, section 9(2) of the Constitution must be complied with. Thus the amendment must be supported by votes of not less than two-thirds majority of members of the House of Assembly, and approved by resolution of the Houses of Assembly of not less than two-thirds of all the states. This procedure is cumbersome because of the time and resources required, and the rigorous procedures involved.

Abuse of Power of Revocation

When the Act was promulgated in 1978, workers and Nigerians who wanted to own their houses heaved a sigh of relief. At last, they would own their own houses without having to purchase land at exorbitant prices from land speculators. The Act gave the Governor the power to revoke a right of occupancy for overriding public purpose.[106] Thus, section 28(1) of the Act provides "it shall be lawful for the Governor to revoke a right of occupancy for overriding public interest." However, revocation can only be valid in the face of overriding public interest including but not limited to the purpose of exclusive government use, development for public good, and on the grounds of preservation of public safety.[107] This power was meant to ensure that the objectives of the Act of providing housing to Nigerians are achieved by making it possible for government to acquire land for building of housing estate/ projects.

However, it does not appear that the objective has been achieved. According to prof. Yakubu, the power of revocation is the part of the Act which frightens many land users.[108] The only class who could get grant of right of occupancy is those who are privileged and the elites[109]. Other Nigerians who require land for residential and other developmental purposes are left to suffer. The process of obtaining grant and the expenses involved have discouraged many Nigerians who wanted land for development.

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[104] Ibid.

[105] Utuama,A.A.(2016) "Underbelly of the Land Use Act: Activating the Wealth of the People. In: Utuama, A.A. (ed.)

Critical Issues in Nigerian Property Law. Malthouse Press Ltd, Lagos, pp.197-198.

[106] Section 28 of the Act

[107] Kindston,K.G. (2016) The Nigerian Land Use Act: A Curse or A Blessing to the Anglican Church and the Ikwerre

Ethnic People of Rivers State. American Journal of Law and Criminology, Volume 6, Number 1, Sacha & Diamond,

England, United Kingdom,p.153.

[108] Yakubu,M.G. (1986) Notes on the Land Use Act. A.B.U Press Ltd,p.37.

[109] Madaki, A.M. (2006) The Land Use Act 28 years after its Enactment: A Critical Assessment, Contemporary Issues

in Nigerian Law. Department of Private Law, ABU, Zaria, p.405

The Act has empowered only the governor to revoke right of occupancy for public interest. Unfortunately, the power is sometimes used to revoke strategically located lands for Nigerians and thereafter given to friends and others close to the corridors of power as rewards for patronage. In *Orianze v. A.G. Rivers State,*[110] the Supreme Court stated that the revocation of right of occupancy is not just a mere executive or administrative act that can be done in secret or any surreptitious manner and later conveyed in official gazette; the holder of the right of occupancy is entitled to be heard before his interest can be validly revoked.[111] Therefore, it is very important for the government to comply with procedures for revocation of a right of occupancy.

Insecurity of Title in Customary Right of Occupancy

Before the enactment of the Act, the customary land tenure in the country did not guarantee security of title. Thus, buying of land from land owning families most especially in Southern states became a game of chance, as in most cases, the purchaser ended up buying lawsuit.[112] This was the precarious situations, and it was expected that with the enactment of the Act, these problems would be addressed. Although there is no provision in the Act specifically preserving the customary land tenure system as an institution, there are different provisions of the Act which unequivocally point at such preservation so that today, there is no doubt that the institution exists.[113] While section 1 swept away all the unlimited rights and interest Nigerians had in their lands and substituted therefor limited rights in the form of a right of occupancy, the transitional provisions recognize and protect existing rights on land in that limited form.[114] Unfortunately, due to the lack of documentation of the customary right of occupancy, the problem of insecurity of title still persists in relation to land covered by customary right of occupancy. Thus, it is easy for unsuspecting members of the public who want to buy land not documented to have comprehensive information on such lands. The Act introduced a right of occupancy as the main basic interest in land in Nigeria and the introduction of a certificate of occupancy is supposed to guarantee greater confidence and assurance to conveyancers in secured credit transactions in Nigeria.[115]

CONCLUSION

The housing industry in Nigeria has faced certain challenges arising from the poor implementation of the provisions of the Act. The Act was enacted to allow access to affordable land to Nigerians, and prevent land speculation. Unfortunately, four decades after its enactment, the impact of the Act has not been felt as a catalyst for sustainable housing development in Nigeria. Many problems militating against the growth and development in the housing industry can be traced to the Act.

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[110] (2017) 6 NWLR (Pt.1561) p.224.

[111] Ibid.p.296

[112] Verity, President of the West African Court of Appeal in *Ogunbambi v. Abowaba* (1951) 13 WACA 222 at p.223

[113] Smith, I.O. (2013) *Practical Approach to Law of Real Property in Nigeria*. Ecowatch Publications, Revised Edition,

p. 116.

[114] Ibid.

[115] Umozulike, I.A. (2006) "The Land Use Act-A Catholic Legislation? "In: Utuama, A.A. (ed) Critical Issues in Nigerian

Property Law. Malthouse Press Ltd, Lagos, p.98.

It is the finding of this paper that the Act being the legal framework for the control and management of land in Nigeria is a critical component in any plan and implementation framework for sustainable Housing development. However, some aspects of the Act have become clogs in the wheel of socio-economic development. A major challenge is the requirement that consent of governor must be obtained before alienation of interest can be valid. The regime of consent requirement has been characterized by exorbitant consent fees, and delays in processing the consent. Secondly, the inclusion of the Act in the constitution has made the Act rigid and irresponsive to changing socio-economic realities. There is no justification for incorporation of the Act in the constitution, and the inclusion of the Act in the Exclusive Legislative is absurd. Finally, the situation where land is vested in the Governor, and only the Governor can revoke right of occupancy for overriding public interest is against constitutional arrangement of the federal system of government operated in Nigeria. Thus, other tiers of government such as the Federal Government have no equal power to revoke land like the state Governor to meet demand of infrastructural development for housing.

It is thus recommended that the procedure for obtaining consent should be simplified to make it easy and affordable for holders of certificate of Occupancy to secure loan for housing purposes. More so, the Act should be expunged from the constitution so that it can be easily amended to address the urgent challenges in the housing sector. Finally, the constitution and the Act should be amended in a way that it will not be difficult for the federal government to acquire land across the country for mass housing delivery and related projects.

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SQL-Driven Spatial Database Transactions in Support of Compulsory Land Acquisition for Road Expansion Projects

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Abstract:
Activities in an electronically-driven land administration organization might warrant the deployment of spatial database queries that culminate in cartographic visualization of the likely outcome of intended land management decisions among which include the compulsory acquisition of land for overriding public interest. This study is an experimentation of spatial database query in the retrieval of information about land and buildings that may likely be affected by the exercise of government's eminent domain powers for the widening of a motorable road in the municipality of Idah in Kogi State, Nigeria. Spatial data for the prototype project area covering three neighbourhoods in Idah municipality were obtained from Google Earth® and OpenStreetMap® and were further processed and analyzed using QGIS® and Spatialite® respectively. Prototype database tables for property owners' identity, parcels, buildings, and roads were created; while structured query language (SQL) operations were instantiated to project the spatial and non-spatial attributes of properties that may be affected under varying scenarios of a proposed road widening scheme. Experimentation of the 10 metre-, 15 metre-, and 20 metre SQL buffer operations returned visually reliable results of the total number and attributes of land and buildings that may be vulnerable to expropriation for the prototype road widening project in the municipality. The value of this study is anchored on the deployment of SQL operations in the planning phase of compulsory land acquisition and compensation.

Keywords: Spatial database, SQL, Land administration, Compulsory land acquisition, Road project.

INTRODUCTION

The expansion of an existing road width to accommodate increase in vehicular and pedestrian traffic in any municipality will entail the deployment of eminent domain powers to avail the local government with land for the implementation of the road expansion project and the provision of associated facilities like drainage and service channels. Sections 28 and 29 of the Nigerian Land Use Act enacted in 1978 provide the legislative foundation for the expropriation of private interests in land for overriding public interest and the assessment and payment of compensation (Federal Ministry of Justice, 2004). While there is a need to identify the number of parcels and landed properties that spatially intersect with the proposed road width, the deployment of the existing manual/analogue processes may prolong property enumeration, budgeting, and fund appropriation to cater for the payment of compensation.

Following the recent federal executive decision to grant financial autonomy to local governments in Nigeria (Ikenna, 2019), it is pertinent that spatial database and information technology tools should be deployed by the local governments to serve as precursors to the enumeration and inspection of parcels and unexhausted improvements likely to be affected by a land expropriation plan. In Kosovo, Meha et al. (2011) demonstrated the practical use of Spatial Data Infrastructure (SDI) and Geographic Information System (GIS) to land expropriation and resettlement for the purpose of public mining operations. Contrary to this feat in Europe, Municipalities in Nigeria including Idah, the study area is yet to develop an SDI let alone adopt digital land administration tools. Furthermore, while Chiemelu & Eze (2014) and Akeh (2018) in related studies, contributed to our knowledge of how GIS software packages can be used to handle cadastral data, little is known from first principle, the language of communication and syntax deployed at the back-end by these software packages for the creation, retrieval, and visualization of spatial data especially during land acquisition for road projects.

With recourse to Idah local government of Kogi State in Nigeria, this study aims to experiment the use of spatial database query in the retrieval of information about land and buildings that may likely be affected by a municipality's exercise of eminent domain powers for the widening of an existing motorable road. Hence, the use of spatial database transactions which is the foundation of GIS platforms is proposed to provide timely and cost effective approach towards the planning and implementation of compulsory land acquisition for the expansion of an existing road network.

REVIEW OF LITERATURE

Compulsory acquisition otherwise called eminent domain, compulsory purchase, land expropriation or resumption pertains to the exercise of legislative powers by the government and its agencies to take possession of private land for overriding public interest and payment of compensation to affected parties (Azuela and Herrera-Martín, 2009; Šumrada et al., 2013). Overriding public interest implies land use for the benefit of the society as against individual benefit (Belej and Walacik, 2008; Šumrada et al., 2013). An instance is the construction, re-construction, and widening of existing road network, which would warrant active involvement of the public works agency and land administration organization (Arvanitis et al., 2008; Šumrada et al., 2013). While the public works agency is concerned with land availability for project implementation, the land administration organization is saddled with identifying the affected parcels and title holders for onward field inspections and cadastre (spatial database) updates culminating into the assessment and payment of compensation.

From the perspective of ownership, roads in Nigeria can be categorized into the Federal government-owned trunk 'A' roads; state government-owned trunk 'F' roads, state government-owned trunk 'B' roads, the Local government-owned trunk 'C' roads (Olubomehin, 2016). The functional classification of these road comprise the arterials, minor collectors, major collectors, and local roads (Raguraman and Sinha, 2006). For the purpose of this study, emphasis is on the trunk 'C' roads among which are local rural roads with prospects of being upgraded to minor collector roads. These transport infrastructure and associated land uses can avail the spatial database expert with insights into their modelling as spatial objects and fields using the OpenGIS® geometry object model designed to show the hierarchy of spatial data types comprising classes and subclasses in Figure 1 below.

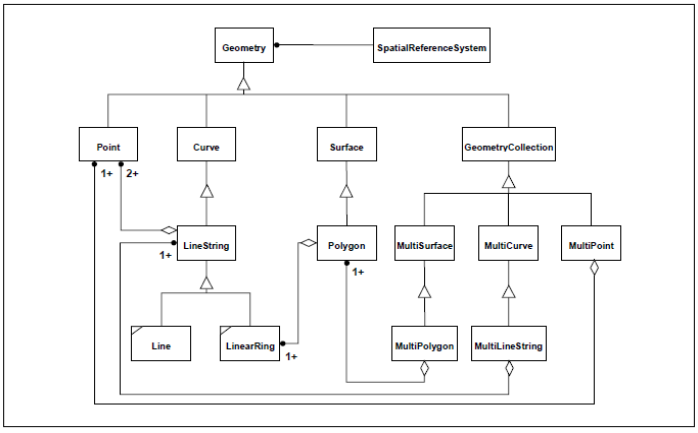


Figure 1: Hierarchy of geometry class

It can be inferred from Figure 1 above that a parcel of land is represented as a polygon in geographic/land information system (GIS/LIS); while collector- and minor arterial roads are represented as linestring. Instantiating GIS buffer functions on a selected linestring would produce a polygon. In addition, a collection of several land parcels into shapefile amounts to

the super class - 'Geometry Collection' in spatial databases. These features (linestrings, polygons, and geometry collections) are tied to the International Terrestrial Reference Frame (ITRF) or spatial reference identity (SRID) chosen by the user (OGC, 1999), which in the case of this article is the WGS84 spatial reference (SRID) with possibility of 'on the fly' map projection to the Minna datum tagged EPSG:26392 as appropriate to the study area.

Spatial database transactions entail the use of Structured Query Language (SQL) aimed at instructing the computer to use Data Definition Language (DDL) to create database structures on the one hand, and/or enabling the use of Data Manipulation Language (DML) to retrieve, alter, and update data tables contained in a geodatabase (Connolly and Bergg, 2005; Menke, et al., 2015; Yeung and Hall, 2007). Providing the foundation and standards for this operation is the OpenGIS® Simple Features Specification for Structured Query Language (SQL) and made applicable to land acquisition for road expansion projects.

There are notable developments in the deployment of automated spatial database creation and query for the Nigerian land administration and cadastral practice, which are anchored on the approaches of cadastral research design proposed by Çagdas & Stubkjær (2011). For instance, Orisakwe and Bakari (2013) developed a parcel-based cadastral information system leading to the production of an automated-composite map of the study area. Using ArcMap as the dominant software, Akeh (2018), Chiemelu & Onwumere (2013), and Chiemelu & Eze (2014), demonstrated the conversion of analogue spatial data into digital and Geo-enabled formats to pave the way for ArcMap-embedded queries, which tend to conceal the fundamental SQL operations at the back-end of the software. Similarly, Abbas et al. (2014) successfully developed a geodatabase of land and buildings in a residential neighbourhood, leading to automated data retrieval without recourse to the fundamental SQL operations; while Kemiki et al. (2015) developed a cadastral information system based on the entity relationship model capable of automated retrieval of multi-criteria data of landed properties still without recourse to the fundamental SQL operations at the back-end of the software.

An observable gap in these studies is the emphasis on software automation without recourse to the fundamental query languages deployed at the back-end of the software to display tables and map outputs. This study addresses the gap by availing interested practitioners with the fundamental machine language associated with the back-end operations of GIS software when implementing land acquisition for road expansion projects. Hence, a spatial analyst can revert to spatial data creation and manipulation from the first principle in the event of limited functionalities in these software packages.

METHODOLOGY

Research philosophy and paradigm

This experimental study was carried out within the framework of Epistemological Pragmatism - a research philosophy that accords credence to the deployment of combined approaches to problem-solving on the condition that the evolved solution(s) can be successfully applied in practice (Saunders et al., 2009). The theoretical underpinning of this study is the use of SQL to support the activity of an electronic land administration organization towards managing compulsory land acquisition for proposed road expansion.

The research techniques

This study entails a combination of design- and experimental strategies. The design strategy was used to develop a model of spatial artefacts comprising land, buildings and road networks, while the experimental strategy was used to instantiate database query scenarios of buffer functions aimed at projecting associated records and cartographic visualizations in connection with compulsory land acquisition for a proposed road widening scheme.

Computer hardware requirements

Features of the Laptop computer deployed for this study include Intel® 2.30GHz Corei7-360QM CPU or Equivalent of 3.6GHz AMD® Ryzen 1800X CPU, 8.00GB of installed random access memory (RAM), and 17 inches visual display unit. Other features include a DVD Writer, Web Cam, USB 2.0 ports, Wireless and Bluetooth antenna, a Secure Digital (SD) card slot and a USB Wifi Dongle as external device.

Software requirement

Software for this study include pre-installed Windows Operating system and Office application suites, and interoperable open-source spatial packages comprising QGIS® 2.8.1 and Spatialite®. Application areas of these spatial software packages are detailed in Table 1.

Data sources and data formats

Vector data layers of the areas of interest comprising neighbourhoods of Igalogba, Ukwaja, and parts of Sabon-Gari in Idah Local Government area of Kogi State were obtained from Google Earth® and OpenStreetMap® (Figure 2). Spatial data pre-processing was carried out in QGIS® 2.8.1 to ensure spatial data consistency prior to their upload in the Spatialite® environment where SQL-oriented database transactions were performed.

Data preparation process

Data processing was carried out in two progressive phases comprising QGIS® and Spatialite® operations. In between both phases is the bridging operation of data importation into the Spatialite® database - Compulsory_Acquisition_Scheme.sqlite created for the purpose of the study. The entire process commenced with QGIS® 2.8.1 operation of file creation, definition of spatial reference system as WGS84 with coordinate 'on the fly' to the Minna/Nigeria Mid belt ITRF - EPSG:26392.

Table 1: Software packages

S/N	Software	Application areas
1	QGIS Desktop 2.8.1	1. Create vector of the study area; 2. Create shapefiles and edit attribute tables; 3. Connect deliverables with the Spatialite® database; 4. Add saved SQL results as layer in the QGIS project; & 5. Cartographic visualization of saved SQL results.
2	Spatialite_gui 2.0.0-devel	1. Create database of spatial and non-spatial objects; 2. SQL Editing and Execution for Tables and Views; and 3. Connect to QGIS for spatial data editing, and cartographic visualization.

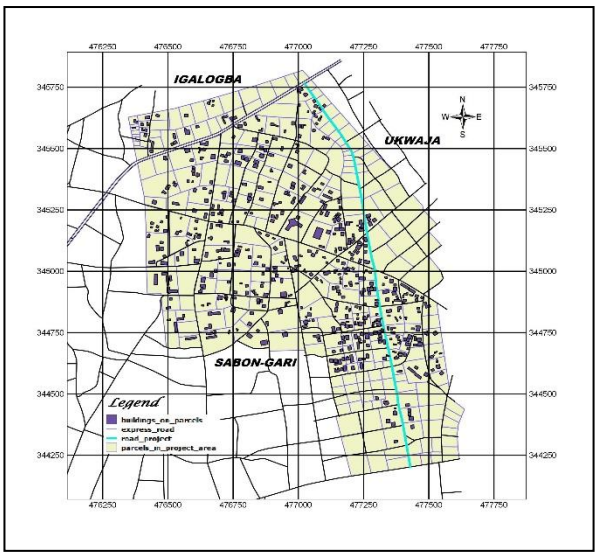


Figure 2: Map of the study area in Idah, Kogi State

Furthermore, the .osm layers for road network (Lines), municipal buildings (polygons) were extracted from the online OpenStreetMap® portal as shapefiles, while the attribute table tagged "*BIODATA.dbf*" for natural persons was created to populate the pseudo-names and pseudo-national identity numbers (NIN) of all parcel owners in the study area. Other fundamental tables created in QGIS® 2.8.1 and exported to Spatialite® include *NNPDATA.dbf* for non-natural persons, *parcels_in_project_area.shp*, *buildings_on_parcels.shp*, *project area.shp*, and *road_network.shp* (Table 2).

The retrieval of records for cartographic visualization was instantiated using the tuple relational calculus statements in Figure 3(a); while the DDL, which can be possibly deployed to create new database table is captured in Figure 3(b). The condition of buffer operation arising from a proposed road expansion is written as *ST_Buffer(ST_Transform(r.Geometry, 26392),X)*; where *X* is the instance of the buffer function in metres, *r* is the selected road with defined identity, and 26392 represents the local (Minna/Nigeria Mid Belt) datum to which the SRID transformation from Geographic Coordinate (WGS84) was performed.

```
SELECT ..An array of tuples....
FROM 'Table 1' AS X, 'Table 2' AS Y, .....
WHERE 'Condition 1' OPERATOR 'Condition 2'
        OPERATOR 'Condition n'
```

```
WITH CTE AS
(SELECT ..An array of tuples....
FROM 'Table 1' AS X, 'Table 2' AS Y, .....
WHERE 'Condition 1' OPERATOR 'Condition 2'
        OPERATOR 'Condition n'
)
SELECT DISTINCT *FROM CTE
```

Figure 3(a): Instances of SQL-DML

```
CREATE TABLE '.....Name of Table....' AS
SELECT ..An array of tuples....
FROM 'Table 1' AS X, 'Table 2' AS Y, .....
WHERE 'Condition 1' OPERATOR 'Condition 2'
        OPERATOR 'Condition n'
```

```
CREATE TABLE '.....Name of Table....' AS
WITH CTE AS
(SELECT ..An array of tuples....
FROM 'Table 1' AS X, 'Table 2' AS Y, .....
WHERE 'Condition 1' OPERATOR 'Condition 2'
        OPERATOR 'Condition n'
)
SELECT DISTINCT *FROM CTE
```

Figure 3(b): Instance of SQL-DDL

Figures 4 and 5 are screen dumps of the graphic user interfaces (GUIs) of the spatial database engines containing the aforementioned shapefiles and database files that were exported from QGIS 2.8.1® to Spatialite® 2.0. Further created in Spatialite® 2.0 using a combination of DML and DDL include tables of buffers-; affected parcels-; and affected buildings within 10 metre-, 15 metre-, and 20 metre scenarios of road widening. The interconnectivity between QGIS 2.8.1® and Spatialite® 2.0 enabled the sharing of database tables for map visualizations.

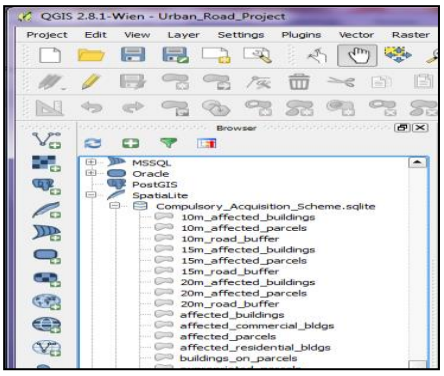


Figure 4: Spatialite browser panel in QGIS

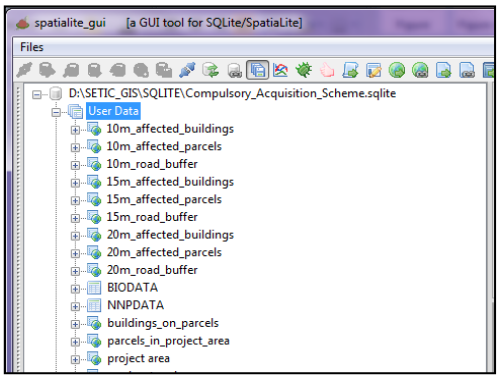


Figure 5: Actual Spatialite browser panel

In Table 2, the first-seven rows pertain to the fundamental data for this article while the rest are SQL derived tables using DML expressions.

Techniques of data analysis and presentation

Results from spatial scenario analysis of compulsory land acquisition arising from SQL (data definition and data manipulation) statements executed in Spatialite® were presented in the form of table of results (tuple selection), and cartographic visualization of vectorized maps reflecting the conditions and constraints of the SQL statements. The implications of the spatial scenario analysis of compulsory land acquisition were discussed.

Table 2: Database Schema

Table	Attributes and data type	Status
BIODATA	OBJECTID: Integer, Name: String, Gender: String, Birth_Date: Date, NIN: String,	Original table
NNPDATA	OBJECTID: Integer, Name: String, RC_ID: String, Coop_type: String, Estab_Date: Date	Original table
parcels_in_project_area	PK_UID: Integer, parcel_id: Integer, land_use: String, title_type: String, max_term: String, grant_date: Date, holder_id: String, perimeter: Real, shape_area: Real, Geometry: Geometry	Original table
buildings_on_parcels	PK_UID: Integer, building_id: Integer, perimeter: Real, Area: Real, Geometry: Geometry	Original table
project area	PK_UID: Integer, Proj_area: String, Perimeter: Real, Area: real, Geometry: Geometry	Original table
road_network	PK_UID: Integer, road_id: Integer, osm_id: Integer, highway: String, Length: Real, Geometry: Geometry	Original table
road_project	PK_UID: Integer, road_id: String, osm_id: String, highway: String, Length: Real, Geometry: Geometry	SQL-derived table
10m_road_buffer	PK_UID: Integer, road_id: String, osm_id: String, highway: String, Length: Real, Geometry: Geometry	SQL-derived table
10m_affected_parcels	parcel_id: Integer, land_use: String, title_type: String, allocation_date: Date, holder_id: String, perimeter: Real, parcel_area: Real, Geometry: Geometry	SQL-derived table
10m_affected_buildings	building_id: String, parcel_id: String, building_type: String, perimeter: Real, parcel_area: Real, Geometry: Geometry	SQL-derived table
15m_road_buffer	PK_UID: Integer, road_id: String, osm_id: String, highway: String, Length: Real, Geometry: Geometry	SQL-derived table
15m_affected_parcels	parcel_id: Integer, land_use: String, title_type: String, allocation_date: Date, holder_id: String, perimeter: Real, parcel_area: Real, Geometry: Geometry	SQL-derived table
15m_affected_buildings	building_id: String, parcel_id: String, building_type: String, perimeter: Real, parcel_area: Real, Geometry: Geometry	SQL-derived table
20m_road_buffer	PK_UID: Integer, road_id: String, osm_id: String, highway: String, Length: Real, Geometry: Geometry	SQL-derived table
20m_affected_parcels	parcel_id: Integer, land_use: String, title_type: String, allocation_date: Date, holder_id: String, perimeter: Real, parcel_area: Real, Geometry: Geometry	SQL-derived table
20m_affected_buildings	building_id: String, parcel_id: String, building_type: String, perimeter: Real, parcel_area: Real, Geometry: Geometry	SQL-derived table

DATA ANALYSIS AND DISCUSSION

The database transactions

The 10 metres scenario of a proposed road widening scheme

If the width of the selected road project with osm_id = 561800328 is to be widened by 10 metres, SQL operations in Table 3 indicated that 23 buildings along the proposed road network shall be affected. The map visualization indicates a sparse distribution of these affected buildings comprising 11 commercial- and 12 residential buildings.

Table 3: 10-metre buffer operation 1

SQL

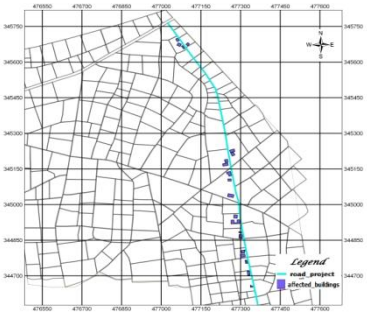
```
CREATE TABLE '10m_affected_buildings' AS
WITH CTE AS
(SELECT b.building_id AS 'building_id', p.parcel_id AS 'parcel_id', p.land_use AS 'building_type',
b.Perimeter AS 'perimeter', b.Area AS 'area', b.geometry AS 'Geometry'
FROM (SELECT ST_Buffer(ST_Transform(r.Geometry, 26392),10) AS geom3
FROM road_network AS r
WHERE r.osm_id = 561800328) AS e, buildings_on_parcels AS b, parcels_in_project_area AS p
WHERE p.title_type = 'customary right of occupancy' AND ST_INTERSECTS(e.geom3,
ST_Transform(b.geometry, 26392)) AND ST_WITHIN(b.geometry, p.Geometry)
)
SELECT DISTINCT *FROM CTE
```

Table output	Cartographic visualization

	ROWID	building_id	parcel_id	building_type	perimeter	area	Geometry
1	1	642107784	1115342400	Residential	52.834500	153.706300	BLOB sz=141 GEOMETRY
2	2	642107799	1115342399	Residential	38.879100	80.191300	BLOB sz=141 GEOMETRY
3	3	642107803	1115342399	Residential	33.661000	57.773600	BLOB sz=141 GEOMETRY
4	4	642108353	1115342405	Residential	42.586900	79.607600	BLOB sz=173 GEOMETRY
5	5	642112824	1115342386	Residential	58.288000	206.341400	BLOB sz=141 GEOMETRY
6	6	642112840	1115342386	Residential	18.771900	22.220300	BLOB sz=141 GEOMETRY
7	7	642112844	1115342386	Residential	47.795300	144.484700	BLOB sz=141 GEOMETRY
8	8	642116821	1115342336	Residential	54.627700	187.514700	BLOB sz=141 GEOMETRY
9	9	642116822	1115342337	Residential	122.770100	394.373100	BLOB sz=221 GEOMETRY
10	10	642116823	1115342337	Residential	54.086300	185.266900	BLOB sz=141 GEOMETRY
11	11	642116829	1115342336	Residential	24.757300	38.028000	BLOB sz=141 GEOMETRY
12	12	642116830	1115342336	Residential	18.727700	22.202000	BLOB sz=141 GEOMETRY

current block: 1 / 23 [23 rows] [fetched in 00:00:00.019]

Total Number of records = 23



The second database query returned 61 results in table and map visualization of parcels and their title holders likely to be affected by the eminent domain powers of the municipality (Table 4). From the third database query, it was found that only 11 out of 61 parcel owners have unexhausted improvements upon their lands (Table 5).

15 metres scenario of a proposed road widening scheme

Applying the same principle in Tables 3, 4, and 5 to the scenario for the widening of the width of selected road project with osm_id = 561800328 by 15 metres, results from the SQL operation in Table 6 indicates that 38 buildings along the proposed road network shall be affected.

Table 4: 10-metre buffer operation 2

SQL

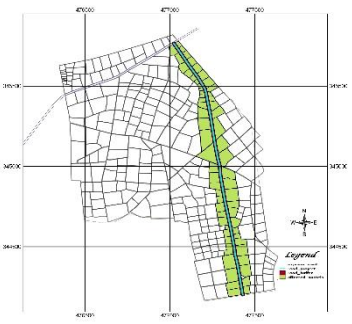
```
SELECT n.Name AS 'Name', n.NIN AS 'NIN', n.Birth_Date AS 'Date_of_Birth', p.parcel_id AS
'parcel_id', p.land_use AS 'Land_use', p.parcel_area AS 'parcel_area', p.Geometry AS 'Geometry'
FROM '10m_affected_parcels' AS p, BIODATA AS n
WHERE n.NIN = p.holder_id
GROUP BY p.parcel_id
ORDER BY n.Name
```

Table output	Cartographic visualization

	Name	NIN	Date_of_Birth	parcel_id	Land_use	parcel_area	Geometry
1	OSEBEYO ESTHER	51967383	1977-07-13	1115342289	Residential	2482.449000	BLOB sz=253 GEOMETRY
2	ISREAL EGBITA HANNAH	38981510	1979-09-16	1115342290	Residential	1365.865800	BLOB sz=189 GEOMETRY
3	LERAMO ADENIYI SUCCESS	33884590	1978-06-25	1115342291	Residential	1013.699400	BLOB sz=173 GEOMETRY
4	AFORGWU JOHN OBOH	43733019	1977-01-22	1115342292	Residential	769.430600	BLOB sz=205 GEOMETRY
5	IMAM TOYYIB	84527466	1978-10-18	1115342293	Residential	653.567100	BLOB sz=189 GEOMETRY
6	ENIWAIYE KEHINDE PAUL	38351265	1976-04-17	1115342294	Residential	797.196400	BLOB sz=173 GEOMETRY
7	SIMEON DARLINGTON ARINZE	68678809	1974-11-03	1115342295	Residential	921.329500	BLOB sz=157 GEOMETRY
8	ABUKA OJOCHE SHADRACH	89832249	1978-11-22	1115342296	Commercial	1427.285300	BLOB sz=141 GEOMETRY
9	PETER DANIEL	50561215	1978-07-16	1115342297	Residential	2260.959200	BLOB sz=141 GEOMETRY
10	OGWUCHE PETER	52374415	1982-11-19	1115342298	Residential	3106.830100	BLOB sz=205 GEOMETRY
11	ENYIOMA OLIVER CHIDERAA	43633246	1985-05-22	1115342299	Commercial	2714.972100	BLOB sz=157 GEOMETRY
12	PAUL INALEGWU EGAPI	83679756	1986-06-30	1115342301	Commercial	2962.198800	BLOB sz=189 GEOMETRY
13	ABDUL SHERIFAT ILEMENYO	41124691	1988-05-26	1115342302	Residential	1192.012300	BLOB sz=157 GEOMETRY
14	HASSAN MUNIRAH A.	99274821	1983-10-05	1115342303	Residential	1363.342700	BLOB sz=157 GEOMETRY
15	NDUBUEZE HAPPINESS	52027008	1988-11-16	1115342304	Commercial	1975.171600	BLOB sz=157 GEOMETRY
16	ADAJI OJODALE JONAH	18335607	1987-08-03	1115342305	Residential	2429.949200	BLOB sz=173 GEOMETRY

current block: 1 / 61 [61 rows] [fetched in 00:00:00.021]

Total Number of records = 61



The map visualization indicates a sparse distribution of these affected buildings comprising 20 commercial- and 18 residential buildings. The second database query returned 62 results in

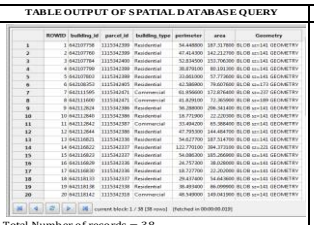
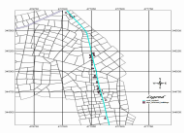
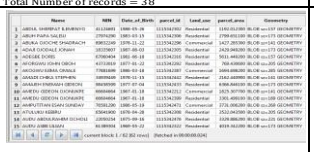
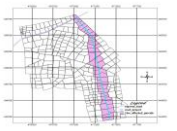
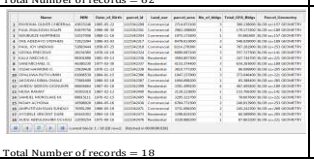
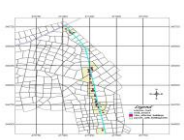
S/N	DESCRIPTION	SQL OPERATION	TABLE OUTPUT OF SPATIAL DATABASE QUERY	MAP VISUALIZATION
1	Spatial database query to create a table for the affected buildings in the parcels that may likely be acquired in part or whole for overriding public purpose of municipal road widening by 15 metres.	CREATE TABLE '15m_affected_buildings' AS WITH CTE AS (SELECT b.building_id AS 'building_id', p.parcel_id AS 'parcel_id', p.land_use AS 'building_type', b.Perimeter AS 'perimeter', b.Area AS 'area', b.geometry AS 'Geometry' FROM (SELECT ST_Buffer(ST_Transform(r.Geometry, 26392),15) AS geom3 FROM road_network AS r WHERE r.osm_id = 561800328) AS e, buildings_on_parcels AS b, parcels_in_project_area AS p WHERE p.title_type = 'customary right of occupancy' AND ST_INTERSECTS(e.geom3, ST_Transform (b.geometry, 26392)) AND ST_WITHIN(b.geometry, p.Geometry)) SELECT DISTINCT *FROM CTE	 Total Number of records = 38	
2	Spatial database query to retrieve the particulars of all land title holders likely to be affected by the eminent domain powers of the municipality for overriding public purpose of municipal road widening by 15 metres.	SELECT n.Name AS 'Name', n.NIN AS 'NIN', n.Birth_Date AS 'Date_of_Birth', p.parcel_id AS 'parcel_id', p.land_use AS 'Land_use', p.parcel_area AS 'parcel_area', p.Geometry AS 'Geometry' FROM '15m_affected_parcels' AS p, BIODATA AS n WHERE n.NIN = p.holder_id GROUP BY p.parcel_id ORDER BY n.Name	 Total Number of records = 62	
3	Spatial database query to retrieve the particulars of all land title holders and the attributes of unexhausted improvements on their lands likely to be affected by the eminent domain powers of the municipality for overriding public purpose of municipal road widening by 15 metres.	SELECT n.Name AS 'Name', n.NIN AS 'NIN', n.Birth_Date AS 'Date_of_Birth', p.parcel_id AS 'parcel_id', p.land_use AS 'Land_use', p.parcel_area AS 'parcel_area', COUNT (b.Geometry) AS 'No_of_bldgs', SUM(b.Area) AS Total_GFA_Bldgs, p.Geometry AS 'Parcel_Geometry' FROM '15m_affected_buildings' AS b, '15m_affected_parcels' AS p, BIODATA AS n WHERE ST_WITHIN(b.geometry, p.Geometry) AND n.NIN = p.holder_id GROUP BY p.parcel_id HAVING COUNT(b.Geometry) > 0 ORDER BY p.parcel_id	 Total Number of records = 18	

Table 5: 10-metre buffer operation 3

SQL

```
SELECT n.Name AS 'Name', n.NIN AS 'NIN', n.Birth_Date AS 'Date_of_Birth', p.parcel_id
AS 'parcel_id', p.land_use AS 'Land_use', p.parcel_area AS 'parcel_area', COUNT
(b.Geometry) AS 'No_of_bldgs', SUM(b.Area) AS Total_GFA_Bldgs, p.Geometry AS
'Parcel_Geometry'
FROM '10m_affected_buildings' AS b, '10m_affected_parcels' AS p, BIODATA AS n
WHERE ST_WITHIN(b.geometry, p.Geometry) AND n.NIN = p.holder_id
GROUP BY p.parcel_id
HAVING COUNT(b.Geometry) > 0
ORDER BY p.parcel_id
```

Table output

	Name	NIN	Date_of_Birth	parcel_id	Land_use	parcel_area	No_of_bldgs	Total_GFA_Bldgs	Parcel_Geom
1	ENYIOMA OLIVER CHIDERAA	43633246	1985-05-22	1115342299	Commercial	2714.972100	3	360.138000	BLOB sz=157 GE
2	NDUBUEZE HAPPINESS	52027008	1988-11-16	1115342304	Commercial	1975.171600	1	93.861600	BLOB sz=157 GE
3	OKPADEGBAYO STEPHEN	72823390	1986-03-03	1115342317	Commercial	8479.613600	2	349.749000	BLOB sz=189 GE
4	PAUL JOY UNEKWU	52683444	1958-07-25	1115342318	Commercial	9214.278300	3	638.241000	BLOB sz=253 GE
5	UZOKA PRECIOUS	28234385	1978-10-19	1115342324	Commercial	6990.087100	2	347.050800	BLOB sz=141 GE
6	KALU NKECHI O.	96501898	1981-05-13	1115342336	Residential	3094.807300	3	247.744700	BLOB sz=221 GE
7	SANI MICHAEL O.	46380230	1977-03-30	1115342337	Residential	4153.374400	2	579.640000	BLOB sz=189 GE
8	OPALUWA RUTH UMIH	61808539	1984-01-15	1115342386	Residential	1947.237900	3	373.046400	BLOB sz=221 GE
9	AMEDU GIDEON OJONUKPE	66604664	1967-01-18	1115342399	Residential	3301.499100	2	137.964900	BLOB sz=189 GE
10	MUSA RAMAT	50303310	1967-02-12	1115342400	Residential	2129.223600	1	153.706300	BLOB sz=141 GE
11	SAMUEL MOROLAKE M.	68815111	1976-02-15	1115342405	Residential	3295.321700	1	79.607600	BLOB sz=221 GE

current block: 1 / 11 [11 rows] [fetched in 00:00:00.018]

Total Number of records = 11

Cartographic visualization

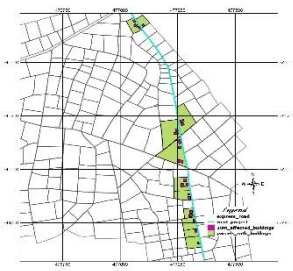


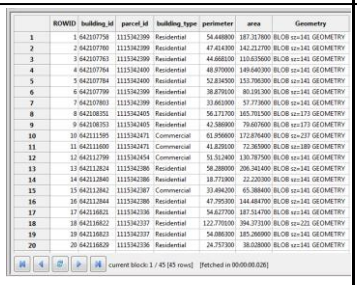
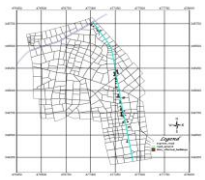
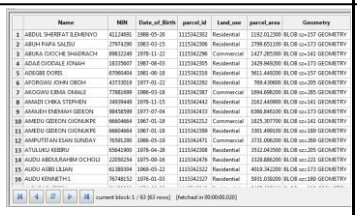
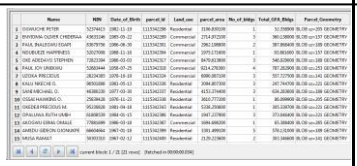
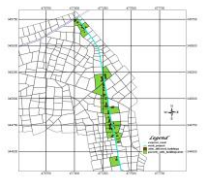
table and map visualization of parcels and their title holders likely to be affected by the eminent domain powers of the municipality. With respect to the third database query in Table 6, it was found that 18 out of 62 parcel owners have unexhausted improvements upon their lands.

The 20 metres scenario of a proposed road widening scheme

If the width of the selected road project with osm_id = 561800328 is to be widened by 20 metres, SQL operations in Table 7 indicated that 45 buildings along the proposed road network shall be affected. The map visualization indicates a sparse distribution of these affected buildings comprising 22 commercial- and 23 residential buildings. The second database query returned 63 results in table and map visualization of parcels and their title holders likely to be

affected by the eminent domain powers of the municipality. In the third database query, it was found that only 21 out of 63 parcel owners have unexhausted improvements upon their lands; amounting to a total of 45 buildings (Table 7).

Table 7: Spatial database query results and visualization arising from proposed widening of an existing road by 20 metres

S/N	DESCRIPTION	SQL OPERATION	TABLE OUTPUT OF SPATIAL DATABASE QUERY	MAP VISUALIZATION
1	Spatial database query to create a table for the affected buildings in the parcels that may likely be acquired in part or whole for overriding public purpose of municipal road widening by 20 metres.	CREATE TABLE '20m_affected_buildings' AS WITH CTE AS (SELECT b.building_id AS 'building_id', p.parcel_id AS 'parcel_id', p.land_use AS 'building_type', b.Perimeter AS 'perimeter', b.Area AS 'area', b.geometry AS 'Geometry' FROM (SELECT ST_Buffer(ST_Transform(r.Geometry, 26392),20) AS geom3 FROM road_network AS r WHERE r.osm_id = 561800328) AS e, buildings_on_parcels AS b, parcels_in_project_area AS p WHERE p.title_type = 'customary right of occupancy' AND ST_INTERSECTS(e.geom3, ST_Transform (b.geometry, 26392)) AND ST_WITHIN(b.geometry, p.Geometry)) SELECT DISTINCT *FROM CTE	 Total Number of records = 45	
2	Spatial database query to retrieve the particulars of all land title holders likely to be affected by the eminent domain powers of the municipality for overriding public purpose of municipal road widening by 20 metres.	SELECT n.Name AS 'Name', n.NIN AS 'NIN', n.Birth_Date AS 'Date_of_Birth', p.parcel_id AS 'parcel_id', p.land_use AS 'Land_use', p.parcel_area AS 'parcel_area', p.Geometry AS 'Geometry' FROM '20m_affected_parcels' AS p, BIODATA AS n WHERE n.NIN = p.holder_id GROUP BY p.parcel_id ORDER BY n.Name	 Total Number of records = 63	
3	Spatial database query to retrieve the particulars of all land title holders and the attributes of unexhausted improvements on their lands likely to be affected by the eminent domain powers of the municipality for overriding public purpose of municipal road widening by 20 metres.	SELECT n.Name AS 'Name', n.NIN AS 'NIN', n.Birth_Date AS 'Date_of_Birth', p.parcel_id AS 'parcel_id', p.land_use AS 'Land_use', p.parcel_area AS 'parcel_area', COUNT (b.Geometry) AS 'No_of_bldgs', SUM(b.Area) AS Total_GFA_Bldgs, p.Geometry AS 'Parcel_Geometry' FROM '20m_affected_buildings' AS b, '20m_affected_parcels' AS p, BIODATA AS n WHERE ST_WITHIN(b.geometry, p.Geometry) AND n.NIN = p.holder_id GROUP BY p.parcel_id HAVING COUNT(b.Geometry) > 0 ORDER BY p.parcel_id	 Total Number of records = 21	

Implications for the planning of compulsory land acquisition and compensation

The type and width of the proposed road project in the municipality would determine the GIS buffer option to be adopted. In this case, the local rural road is proposed to be widened to a minor collector passing through residential and commercial land parcels. From the SQL-driven spatial database transactions, the 10 metres road width expansion scenario attracts the least acquisition cost with 61 affected parcels and 23 buildings. However, if the 15 metres or 20 metres option is to be adopted, the marginal increase in affected parcels is unity but with a higher cost of assessing and paying compensation for more unexhausted improvements (38- and 45 buildings) held by a total of 18- and 21 persons respectively. These results align with a similar study conducted by Meha et al. (2011) in Kosovo where GIS operation was found to provide spatial- and attribute information for the cost of land expropriation in connection with a mining project.

CONCLUSION

This study experiments the possibility of using SQL-driven transactions to identify parcels and unexhausted improvements on land that might be affected by eminent domain powers of the municipality for the purpose of road expansion projects. With respect to the 10 metre-, 15 metre-, and 20 metre scenarios for the widening of an existing road, a combination of DML and DDL have been proven to successfully retrieve spatial and non-spatial attributes of affected properties, and then create database tables of query results for onward map visualization. The limitation of this study is that field inspections would be required to update and validate the

spatial data repository of the municipal lands office especially in the areas where new buildings are developed prior to the effective date of expropriation. Nevertheless, the success of these operations has underscored the importance of comprehending the back-end operations of GIS software along with its application to spatial database transactions associated with compulsory land acquisition for road expansion projects.

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Africa's Population Growth: Adopting the Smart City Model in Nigeria as a Blueprint for its Future Cities

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Abstract:

Africa is currently experiencing impressive population growth and Nigeria at the helm of it all, the continent is envisioned to hit a population of 2.4 billion between 2016 and-2025. This population growth will highly favour urban areas over rural areas but also pose a threat if these cities are not ready to harness the population potentials. Lagos with its alarming population growth has taken a proactive step to begin the construction of a smart city called the Eko Atlantic city. But Lagos is not the only city which has an alarming population on the other end of Nigerian Map is Kano state with a highly growing population and also a high commercial presence. This paper aims to bring to foresight the need for Nigeria to be responsive towards its population growth and in that regard make proactive design considerations in planning her cities. Through a critical review of literature gathered from secondary data of similar situations from countries around the world that have overcome similar challenges and analysed through content analysis. Findings reveal that a major setback of smart cities evolving in Africa is as a result of economic, environmental, cultural and financial factors. It is however recommended that while implementing government policies, urban development agencies should take into consideration the rapid growing population in the planning of its cities to meet the sustainable, resilient and responsive cities as advocated by the UN sustainable development goals.

Keywords: *Population, Urbanization, Smart Cities, Sustainability, Nigeria.*

BACKGROUND TO STUDY

The world faces a challenge of population upsurge with Nigeria experiencing an increase which will gradually become a threat if not checked in time. The nature of population increase in Nigeria has been termed as rapid rate of urbanization characterized by economic growth without infrastructural development. This kind of development is characterized by a major neglect of the rural areas and little improvement on infrastructure to support the growing population in urban areas, the cons will be that it chauffeurs in pressure on limited resources while escalating social inequality. The UN-Habitat (2006) asserts that in the next two decades 95% of growth in the developing world will be in the cities. Venables (2016) asserts that the African continent needs to build at least twice the urban capital stock that it has built over the whole of its previous history, a state of emergency on infrastructural development. Similarly, Lagos state has been ranked the fastest-growing city overall in the 2017-2030 timeline according to (Euro monitor international, 2018). Meanwhile, the year 2030 marks the target deadline for the sustainable development goals by the United Nations Development Programme. These SDGs are set out goals to promote prosperity in the world while protecting the environment, these 17 integrated goals are a call by the United Nations for forward development and amongst these 17, 1 goal directly affect the development of future cities.

Goal 11: sustainable cities and communities.

The research intends on increasing habitant's productivity by establishing healthier communities, reducing carbon footprint and ensuring a healthier community through sustainable design and healthy community living, in that regard; the adoption of smart city concept in the blueprint design of megacities can increase the operational efficiency and improve the quality of life of habitants of that city.

The state of urbanization in Africa

Major African cities are experiencing rapid development, they are now over populated when compared to rural areas, Africa has been dubbed to reach majority urbanized state by the year

2030 (WUP 2005). Fay and Opal (2000) made a case that the rate of urbanization is not as a reflection of the economic growth, they said it has nothing to do with the economic growth of the country rather in the African context that it is an inverse relationship to the level of urbanization in a country. Most developing countries share a particular sentiment towards urbanization and decide to develop the rural communities. However research has proved this wrong and that developing the rural area will not reduce urbanization if anything it will act as an enabler to the exodus of rural to urban migration to continue as seen in Fig 2.1.

Africa's rapid urbanizing population

While the rest of the world host the most urban population for now, it is projected that Asia and Africa will host most of their population in urban areas from 2030 going forward, and will continue to dominate. Most investors are looking at the young urbanizing population of Africa as the future of the world due to the various opportunities that comes as an advantage of population. Asia with 54.5 percent of its population living in cities, and Africa with 53.5 percent of its population urban. Asia alone will account for more than half the world's urban population (2.66 billion out of a global urban population of 4.94 billion); and the urban population of Africa (748 million) will by 2030 be larger than the total population of Europe at that time (685 million).

Competition between urbanizing cities

It is often important that the definition of cities does limit it to be viewed on the bases of population, cities are more than just concentration of people and resources, and it is a hub for trade, culture, information and industries. In developed countries cities drive the economy by generating over 80 percent of the national economic output. Developing cities economies are globally reliant on advanced producer service for their income. In today's economies major cities play pivotal roles in global networking not just by producer service for goods or a host for institutions but also generating related economic and civil society activity in other cities. In the new millennium, cities around the world are already beginning to have several key impacts on developing regions as well, these cities have been able to link resources, population and revenue together, cities like Lagos are already establishing cultural trends in their countries, regions and countries, also included are cities like Istanbul and Mumbai.

Table 2.1 Showing the Rural and urban population by region in 2005 and as projected by 2030

Population (Millions)	Europe	North America	Africa	Asia	Latin America and the Caribbean	Oceania
Rural Population 2005 - (Millions)	0-700	0-400	0-800	0-3900	0-500	0-100
Urban Population 2005 - (Millions)	0-500	0-250	0-350	0-1600	0-450	0-100
Rural Population 2030 - (Millions)	0-650	0-500	0-1500	0-4800	0-650	0-100
Urban Population 2030 - (Millions)	0-500	0-350	0-700	0-2600	0-550	0-100

Source: United Nations, World Urbanization Prospects: The 2003 Revision.

Table 2.2 urban growth in the world's largest cities, 1950-2020

Population (Thousands)	New York	Tokyo	Lagos	Sao Paulo	London	Delhi
Rural Population - 1900 (Thousands)	12,500	11,000	1,000	2,500	8,000	2,000
Urban Population - 2005 (Thousands)	18,000	35,000	12,500	18,000	7,500	15,500
Rural Population - 2015 (Thousands)	19,500	36,000	17,000	20,000	7,500	21,500
Urban Population - 2020 (Thousands)	20,000	37,000	21,000	21,000	7,500	24,000

Source: United Nations, World Urbanization Prospects: The 2003 Revision

Smart city paradigm

The world has presented a significant number of future city models in order to improve the management of population and resources addressing urban processes and inhabitants requirements, for the most part of the 20th century the smartness of a city was a media science fiction, but as a result of telematics and ICT development it has become a reality, ICT development on one hand has helped in automation, monitoring, analysis and planning the city. Sabr (2016) asserts that smart city is rooted in intelligent infrastructures ICTs-Human connections. He pointed 3 axes which the city growth must pay attention to:

i. Sustainability: by improving the city/environment relationship and using green economy.
ii. Smartness: context aware economy and governance.
iii. Inclusiveness: by fostering a high-employment, economy delivering social and territorial cohesion.

Smart cities' concept can be seen as the surest way to have sustainable, liveable, secure and connected city designs, through the use of ICT.

Nam and Pardo (2011) opined that a city is smart when it has achieved economic sustainability growth fuelled by its investment in human and social capital, modern transport system, communication infrastructure and a participatory government that manages its natural resources well.

Caragliu *et.al* (2013) suggests, smart growth encompasses not just transportation but a mind-set towards creating a holistic and sustainable community with great quality of life.

Geller (2003) asserts that it is a self-decisive and independent city, with great performance in its economy, government, people, environment and living.

Consequently, desk study has highlighted the under listed variables as a result of their implication in the adoption of smart city ideas in the design of future cities in Africa. However some weigh more than others and have better implication of fostering this course rather than hindering it in the most effective way.

i. Sustainability
ii. Internet of things (IoT) incorporation
iii. Global Inclusiveness
iv. Public and Private Partnerships
v. Political will
vi. Citizen Participation

Harnessing Nigeria's population in creating smart cities

Identifying the indicators that make a smart city a smart city lie in different concepts, that is why in dealing in urban development related topics like smart cities Roche *et., al* (2012) asserts that smart cities are like an urban area with a layer of technology, overlaid on the urban structure and fabric of the city. This establishes a major relationship between ICT features and infrastructure; which creates an environment for citizens of that city to share, interact, bringing on the net different stakeholders to transfer real time information between each other and the city. Thereby optimizing the city's potentials to development. Since smart cities will depend on population, in 2017 during the Nigerian smart city summit, Demola (2017) opined that it was time for Nigeria to harness it population as a reality rather than a threat adopting a polycentric approach to sustainable urban development. The use of "Swarm Intelligence", which is a decentralized system that makes use of the organization of a collective population sort of how ants work together in their environment to achieve a common goal, this intelligence system relies on feedback from various electronic devices like handheld devices to give feedback of the environment and the same concept is what is used in Google maps to give

feedback on real time traffic situations and the more population it gets feedback from the more accurate the result. Thereby using technology to successfully harness population in giving accurate information.

The global smart city index Fig 2.2 above shows a low rating of the only two Nigerian cities that made it to the ratings and out of a total of 102 cities that were rated. It revealed that Abuja was ranked 97th and Lagos state ranked 102nd both with a "D" rating. These cities are renown as one of the fastest growing cities in the world and a the biggest city in Nigeria respectively according to the United Nations; and with the 2030 SDGs deadline approaching, Nigeria should be looking to harness its already existing population as a catalyst to adapt some of its most populated cities into smart urban spaces.

Smart city index

Table 2.3 showing amongst a host of other cities the rankings of Nigerian cities according to the smart city index

1-10 Ranked Countries

Overall ranking	City	Overall rating
1	Singapore	AAA
2	Zurich	AAA
3	Oslo	AA
4	Geneva	AA
5	Copenhagen	AA
6	Auckland	A
7	Taipei city	A
8	Helsinki	A
9	Bilbao	A
10	Dusseldorf	A

93-102 Ranked Countries

Overall ranking	City	Overall rating
93	Cape Town	C
94	Manila	C
95	Athens	C
96	Rio de Janeiro	C
97	Abuja	D
98	Bogota	D
99	Cairo	D
100	Nairobi	D
101	Rabat	D
102	Lagos	D

Source: United Nations, World Urbanization Prospects

METHODOLOGY

Qualitative research method was used in carrying out this study, using content analysis once the sources (articles) were selected for inclusion in the study. Relevant literature sources in context with the title of the paper as regards urbanization and smart city development was recorded in a spreadsheet. The spreadsheet was designed containing columns that were established considering the indicators deduced from desk study. Consequently, the study considered a total of 80 articles which were initially identified. The articles include 70 that were electronically accessed amongst thesis writings as well as journal articles. Thereafter the study exclusively made use of 63 articles which were selected and evaluated using the keywords and title to select only the papers who dealt with the aforementioned variables to determine which would be relevant to the study. After reading the abstracts and considering which of them provided information on sustainable urban smart cities, 50 articles were selected for the final analysis.

Across these literatures it was observed that there exist significant levels of inconsistences, while some authors may come to a definitive conclusion others seem to conclude with setting up of criteria, suggestions or even indicators. Therefore data were coded in more general terms to suggest were they would best fit, however this designations where further explained in the research discussions.

Despite the efforts to assemble systematic relevant data in the context of this study, it was met by certain limitations. For the first part this research is entirely limited to journal articles; secondly, the content analysis is drawn from the conclusions of the works of other authors, with little or no space to argue the quality of their findings, biases and conclusions. However

it is a work that presents a broad reading of literature, findings, trends, consistencies reported by other researchers.

Table 3.1: showing variables for the study

SN	VARIABLES
i	Sustainability
ii	IoT Incorporation
iii	Global Inclusiveness
iv	Public And Private Partnerships
v	Political Will
vi	Citizenry Participation

Source: United Nations, World Urbanization Prospects

Table 3.2: Showing Articles reviewed for comparative study

Sn	Author(s), Topic	Year	Themes
1	Margerum, R.D (2002).; ***Evaluating collaborative planning: Implications from an empirical analysis of growth management***	2002	Citizens and civil society should Participate in the formulation and enforcement of urban policies.
2	Kim, H.-J. ;***Smart era, expansion and transformation of urban planning***	2007	Smart city era would change urban planning as it is known just as the introduction of ICT revolutionised e-services.
3	Washburn, D.; Sindhu, U.; Balaouras, S.; Dines, R.A.; Hayes, N.; Nelson, L.E. ***Helping CIOs understand "smart city" initiatives***	2009	The use of the Chief information officers (CIO) expertise to further interoperability of smart city systems and stakeholders.
4	Ramin Keivani; ***A review of the main challenges to urban sustainability, International Journal of Urban Sustainable Development***	2010	A Necessity to understand sustainability and break the 'silo mentality' of the disciplines that are involved in urban development.
5	George C L;, Mariacristina R; ***Definition methodology for the smart cities model***	2012	Smart city models should be simple and comprehensive to citizens.
6	Lazaroiu, George Cristian & Roscia, M.; ***Definition methodology for the smart cities model. Energy.***	2012	In the modelling of a real city's smart city plan expert contribution from various chosen fields should be involved in the research to enable a very workable city model.
7	Cho, Young. ***Designing Smart Cities: Security Issues.***	2012	Use of CCTV detection and speech recognition in smart cities.
8	Cretu, L. G.; ***Smart cities design using event-driven paradigm and semantic web***	2012	The architecture of Event-driven Smart City is the kind of city where digital artefacts enable the interoperability between Internet of Services.
9	Deakin, Mark.***From Intelligent to Smart Cities: CoPs as organizations for developing integrated models of eGovernment Services.***	2012	European cities using the intelligence of **communities of practice (CoPs)** as the organizational means to be smart in developing models of eGov services.
10	Beniamino, M.; Giuseppe, B; ***Cities and Smartness: A Critical Analysis of Opportunities and Risks.***	2013	Coordinating and harmonizing urban players through ICT.
11	Claudio Marciano; ***Unpacking a Smart City Model: The Hegemony of Ecological and Information Paradigms in Urban Space***	2013	Maintaining a sustainable and zero energy lifestyle.
12	Emre Ronay Roman Egger; ***NFC Smart City: Cities of the Future A Scenario Technique Application***.	2013	The implementation of ICTs in cities is the key success factor to encounter the global problems like achieving sustainability.
13	Khan, Zaheer & Anjum, Ashiq & Kiani, Saad. ***Cloud Based Big Data Analytics for Smart Future Cities. Journal of Cloud Computing.***	2013	Use of Big data for processing data, Cloud-based analysis service that can be developed to support decision making.
14	Bettencourt, Luís. ***The Uses of Big Data in Cities. Big Data.***	2014	The use of big data must be to continue to enable the creation of new knowledge by people and not replacing it.

15	Angelidou, M. ***Smart city policies: A spatial approach. Cities***	2014	Certain spatial factors differentiate smart city development policies.
16	Wenge R, Zhang X, Dave C, Chao L, Hao S ***Smart city architecture: a technology guide for implementation and design challenges.***	2014	Architecture designed from different perspectives of technological knowledge to address the sustainability challenges of future
17	Neirotti, P.; De Marco, A.; Cagliano, A.C.; Mangano, G.; Scorrano, F. ***Current trends in smart city initiatives: Some stylised facts.***	2014	Policy makers in leadership roles must find ways to relieve the path dependence on technology adoption.
18	Moir, E.; Moonen, T.; Clark, G. ***What Are Future Cities? Origins, Meanings and uses.***	2014	The concept of digital city have been almost totally replaced by the concept of the smart city, which aims to operate integrated cities.
19	Korea Communications Agency. ***Smart City of Major Countries around the World Analysis Case; Policy Research Division Fusion Policy Research Department in Korea: Seoul, Korea***	2014	Songdo city will be built as a high-tech **business city** with ICT convergence through the Songdo City Integrated Operation Centre
20	Angadi, Srinivas & Padmavathi, M & Mamillapalli, Raja; ***Challenges in Adopting Smart City Concepts and their Sustainability in Indian Conditions.***	2015	Concept of a smart cities is as a system consisting of multiple systems, with no preferred framework of adoption.
21	Sethi, Mahendra; ***Smart Cities in India: Challenges and Possibilities to attain Sustainable Urbanization.***	2015	The urban planning effort of harmonizing technology, government policies, urban planning and sustaining all by ICT.
22	Mattoni, B., Gugliermetti, F., & Bisegna, F. ***A multilevel method to assess and design the renovation and integration of Smart Cities. Sustainable Cities and Society***	2015	A way to integrate the various aspects of a Smart City is a balance among hardware and software aspects, technology and human capital through the definition of the relations existing among all the subsystems of the city, considered as a whole (human) organism.
23	Haq, Muhammad & Merish, Adnan & El-Abd, Mohammed. ***A Smart City Model Implementation.***	2016	The use of a hierarchical control structure model to solve major environmental problems.
24	Cilliers, Liezel & Flowerday, Stephen & McLean, Sean.; ***A crowdsourcing, smart city model for a developing country***	2016	Adopting a smart city to a developing country majorly requires; the city management, trust of citizens and the crowdsourcing system.
25	Karakiewicz, Justyna; ***EVER SMARTER, CITIES THAT LEARN: the application of complex adaptive systems theory to urban development.***	2016	Adequate attention should be given to the city structure design through the implementation of complex feedback loop systems in creation of resilient cities.
26	Dlodlo, Nomusa. ***The internet of things for the safety and security of smart cities.***	2016	The adoption of IoT in in carrying out various city logistics like crime detection indicators, crowdsourcing and crowd sensing.
27	Adnan, Yasmin & Hamzah, Hasniyati & Md Dali, Melasutra & Md, Dali & Daud, Mohd & Alias, Anuar. ***Comparative Overview of Smart Cities Initiatives: Singapore and Seoul.***	2016	Singapore's highest place in the ranking index was assured by its full commitment in using ICT to improve all facets of city development.
28	Arroub, A., Zahi, B., Sabir, E., & Sadik, M. ***A literature review on Smart Cities: Paradigms, opportunities and open problems***	2016	Many Smart City initiatives are intensively using technology (ICT).
29	Bifulco, F., Tregua, M., Amitrano, C. C., & D'Auria, A.**;** ***ICT and sustainability in smart cities management***	2016	Development of new smart city models that integrate drivers, ICT, and sustainability in an all-in-one perspective.
30	Peyman, K., Hamid, F., and Samira, M.; ***Planning for Future Urban Services in the Smart City Era: Integrating E-services in Urban Planning Process***	2016	An integrated conceptual service delivery process as well recommendations for integrated development of e-services from different planning dimensions.

31	Charles Consel, Milan Kabáč. ***Internet of Things: From Small-to Large-Scale Orchestration.***	2017	IoT infrastructures range from small scale (e.g., homes and personal health) to large scale (e.g., cities and transportation systems).
32	Gebhardt, Christiane. ***Humans in the Loop: The Clash of Concepts in Digital Sustainability in Smart Cities.***	2017	The transition from normal cities to smart cities is a socio-economic problem of ensuring sustainability and a visionary government.
33	Matijosaitiene, Irina & Petriashvili, Ana; ***Urban Planning and Design for Terrorism Resilient Cities. Journal of sustainable architecture and civil engineering.***	2017	Professionals should consider Crime Prevention Through Environmental Design (CPTED).
34	Hasbini, Mohamad Amin & Tom-Petersen, Martin; ***The Smart Cities Internet of Access Control, opportunities and cyber security challenges.***	2017	IoT is the best option in access control in overpopulated metropolises around the world however it poses a threat to cyber security which is still under perfection.
35	Taylor Buck, N. ***Competitive urbanism and the limits to smart city innovation: The UK Future Cities initiative***	2017	The development of new technologies made possible the connection of independently developed devices share data.
36	Parth, J S;, Theodoros A;, Arkady Z;, Sara B: ***A stochastic optimization framework for planning of waste collection and value recovery operations in smart and sustainable cities***	2018	Harnessing IoT in smart city management using sensors.
37	M Nagabhushan, K.Nikitha, C.Lakshmi, C.Karthik; ***Internet of Things on Smart Villages***	2018	IoT combines the benefits of multiple technologies, the result is an intelligent city.
38	Achmad, Kusuma & Nugroho, Lukito & Djunaedi, Achmad & Widyawan, Widyawan. ***Smart City Model: a Literature Review.***	2018	Review of IoT systems that deal with peoples demands improving living conditions of populations and encourage creative economy.
39	Sinha, Deepak; ***The Counter Terror Dimension to the Planning of Smart Cities.***	2018	Counterterrorism requirements should have statutory backing in order to make not just smart but safe cities.
40	Smart City Stakeholders ***Stakeholders Analysis, SMART CITY SOLUTIONS.***	2018	The level of stakeholder integration, and their close collaboration is integral to the achievement of mutually beneficial end results.
41	I Makarova, A Boyko, I Giniyatullin and A Ahmadeeva; ***Development of transport infrastructure in smart cities.***	2019	Develop smart mobility system using eco-friendly smart mobility systems.
42	Jiongxu Mou; ***Mining and forecasting of infectious disease transmission data based on smart cities***	2019	In disease management and pandemics introduction of technology in the form of smart indicators and prediction systems result in early detection and better management.
43	Dora S; ***Measuring the smart cities performance in the capital cities of the EU***	2019	Smart city definitions are basically 3 groups which are; technology oriented, complex theories and ranking method.
44	Khalatbari Limaki, Armita; ***Climate change and urbanization responsibility: A review of smart city importance in reducing the negative impacts of urbanization.***	2019	For better energy conservation in cities Architects must design intelligent structures that synergizes the fundamental items of intelligence; Big data, IoT and ICT.
45	Anthopoulos, Leonidas & Janssen, Marijn & Weerakkody, Vishanth. ***A Unified Smart City Model (USCM) for Smart City Conceptualization and Benchmarking***	2019	The model uses ICT and technology to create a more enabling thriving environment.
46	Nigel J. W. Browne; ***Regarding Smart Cities in China, the North and Emerging Economies—One Size Does Not Fit All***	2020	Emerging economies cannot rely on one model in adopting IoT.
47	Gustavo C. N., Elaine T.; ***Assessing the Role of Big Data and the Internet of Things on the Transition to Circular Economy***	2020	Circular economies (CE) are driven by population pressures.

48	Michal Lom & Ondrej Pribyl; ***Smart city model based on systems theory***	2020	The Information management approach i.e. the strength lies in information sharing.
49	Schwarz-Herion, Odile. ***The Role of Smart Cities for the Realization of the Sustainable Development Goals.***	2020	The demand of energy amount and resources needed in running a smart city would hamper the attainment of the SDGs.
50	Mervi Hämäläinen ***A Framework for a Smart City Design: Digital Transformation in the Helsinki Smart City.***	2020	The framework considers a smart city from the perspective of four dimensions: strategy, technology, governance, and stakeholders.

RESEARCH DISCUSSIONS

This section of the research discusses the results of the 50 selected articles, the discussions include the similarities and trends, to highlight the critical indicators that define the typology of a smart city model for Nigeria. The discussion categorises the themes from the articles in 6 smart city phrases which are: Smart Economy, smart people, smart governance, smart mobility, smart environment and smart living, as much as this phrases are used in categorising the thematic summary on scholars' discussions, it does not meant they are exclusive to the discussion on the subject matter. The smart city topic is a complex one that entails an intertwined relationship between all categories for it to be successful nonetheless. This phrases common to the smart city context are further broken down to make clear their emphasis under the subheading in the research discussions.

Categories

Table 4.1: Showing the trend in years and progression of smart city themes

SN	YEARS	TRENDS	THEMES
1	2000 - 2005	Smart city policies	Smart Governance Smart Economy
2	2005 - 2010	Access to and sharing of information amongst governments by the use of ICT	Smart Governance Smart Living
3	2010 - 2015	The Sustainable development goals	Smart Living Smart Environment
4	2015 - 2020	Harnessing the power of IoT to fully achieving Smart cities	Smart People Smart Mobility

DISCUSSIONS

Smart Environment

India uses sustainable policies as a result of their demographic make. These adoption fosters harmony between government planning and the urban populace confirming smart city development as a social problem and it has treated it as such, the Nigerian makeup is a demography comprised of different units or sub systems no different from India and both environments having an alarming population, contrary to the way sustainability in smart cities are portrayed as a green flourishing city and even though it would be one, running a smart city in Africa requires a lot of energy and it seems unlikely that the 2030 deadline for the SDGs is anyway realistic date. Through design professionals in the built industry especially architects can guide the progression of this curve and for starters prevent crime by adopting sustainable methods of designing smart cities such as the use of CPTED, other sustainable design considerations can be made to usher Africa smoothly into an era of smart cities, but firstly, a conscious mind set in design.

Sustainability is a multifaceted topic and there is a need for deeper understanding of the disciplines involved in ensuring a sustainable society to break the wide silo mentality amongst environmental science professionals and create a sustainable balance between hardware,

software, technology and human capital to propagate Smart living, proper pollution and waste management ensuring attractive natural conditions.

Smart Mobility

The incorporation of ICT into urban development has brought about IoT which involves the use of many electronic sensors to collect and manage data. In fact in a comparative study of Seoul and Singapore, a major contributor as why Singapore ranks highest than Seoul in the study and also tops the smart city index rankings is as a result of its commitment to using ICT in developing several facets of its developments in the country. Looking at the budding population of Africa it is easier to understand the role it would play in IoT incorporation, according to data on mobile subscription in 2015 the result showed 7.2 billion subscriptions worldwide with three-quarters of that coming from Africa and Asia, this young internet hungry population is a reservoir which this numbers can aid in information management. The use of IoT combines many technologies and devices already in use to send back an information about a city they are already in, although there is a disadvantage in overpopulated areas when it comes to internet of access control, this threats creates an opportunity in advancing cyber security. The big city data would continue to create and enable new knowledge and not replace it, by making people smarter.

A key advantage of adopting IoT in designing future smart cities is that they can leverage small to large infrastructure, from as little as a start light or signage on a storey building the cloud based big data is able to generate intelligent information to support decision making in the city, from vacancy of spaces for rent down to the weather report a constant loop of intelligent transfer.

In waste management in the city smart bins can be used to gain feedback on type of waste collected, in tourism and also in logistics to track and ensure security.

IoT incorporation encompasses living in good health conditions and public security, in the category of data mining and model prediction; a comparison study between using traditional infectious disease management and smart indicators in the case of a pandemic to detect and curb the spread and death tolls, the introduction of ICT in form of the ARIMA model to detect arising cases proved effective, this model uses a learning algorithm to predict future trends, in china where the study was carried they face an important challenge in low detection rates, low pathogen diagnosis rate, low screening rate and high drug resistance rate. Early prediction warning models improve the chances of survival of infected patients and based on this reduce the effect of the pandemic.

Smart Living

E-governance offers collaborative opportunity between government and in all forms of smart governing the use the cloud based big data to be able to support decision making, smart governing provides opportunity for transparency in government and also policy making, global sustainable actions like having a circular economy is checked towards ensuring sustainable cities creative and collaborative economies. The smart city governance is one that ensures dialog before decision making in the smart ecosystem. In Europe the smart governance ecosystem is funded by global international organisations as digital urban development is a prioritized agenda to ensure sustainable environment development, smart governance is like being a government part of a coalition of government with similar global agenda such as achieving the sustainable development goals.

Smart Economy

Public and Private partnership are encouraged in achieving this vision since both are stakeholders and beneficiaries in the eventuality of a smart city, currently different researches are going on around the world for countries to create their own smart city; creative channels

for city building encouraging local innovations, the possibilities of CE and other smart city innovations in different scales across the major key stakeholder sectors, the smart city model encourages the smartness of an individual or a the people this can further foster the smartness of the city and improve security by making use of crowd sensing, street lighting to give feedbacks, this can surely be supported by partnership of these sectors. Critical study revealed that economically the smart city uniformly deals with innovations (mostly ICT-based) in the urban space that aims to enhance 6 dimensions (people, economy, government, mobility, living and environment) in other words smart cities would encourage running an innovation based economy, which is a more sustainable economy just like the CE rather than the crude oil economy which encourages unsustainable practices. In the limitation to such innovations a study on the future of U.K cities draws attention to weakened capacity of urban governments to control their infrastructural destiny and also constraints on the ability of the public and private sectors to innovate.

Smart Governance

Certain Progressions in governments are implored to create policies that support technological advancement in the design of urban areas, such as using IoT systems to harmonize key urban players by the government in urban planning, to produce high value services and economical innovations after observing citizen demands; the government's willingness and responsibility to address some of this demands will yield in a more sustainable community, adoption of a smart city can in fact help understand the plight of the people, through feedback from sensors that retrieve data in the most affected areas. In prioritizing dialog as a government with key stakeholders before making smart city decisions, the discussion becomes inclusive harnessing crowd sourcing and crowd sensing for better progression. In Helsinki governance attracts various organisations and stakeholders, smart city governance ensures an approach that secures all stakeholder interest and manage their common affairs, providing strategic leadership that considers long term financial needs such a political environment is what is needed to a thriving economy, in the planning of a smart city there is slow progress in political rivalry. Leadership should encourage adoption of smart city as it reduces a wide range of corrupt practices because governance becomes transparent, this sole reason can however be a major reason why the most corrupt countries are sort of hesitant into adopting smart city ideas. But the stakeholder integration, and collaboration between stakeholders is important in the achievement of mutually beneficial end results like flexibility of labour market, sustainable resources management and public and social services provision.

Smart People

How smart can a city really be without involving its citizens, this first hand is essential to a fully functional smart city. Having the confidence of the citizens in the smart city initiative is one of the variables to ensure success, because unless a large amount of people participate the project cannot be successful. In crowdsourcing which is an integral aspect of ensuring a successful smart city model, fuelled by population pressure crowd sourcing takes into account two important constructs; information security and user experience. Many cities are adopting the use of ICT and taking advantage of the citizen participation to effectively share information within the cities, just as in the use of social media, almost everyone in the cooperate world has an email or a Facebook account, today Facebook is amongst the biggest sellers of information and this large amount of data would not be possible without people participation. In the planning of urban policies civil societies and citizenry must participate as it helps for transparency and builds trust. Smart living entails healthy living conditions of individuals in a smart community, innovations for infectious disease spread through the use the data collected

from citizens is able to forecast more accurate results on spread according to a research in china, the accuracy is relative to the citizenry participation.

POLICY IMPLICATIONS AND CONCLUSION

The study revealed the need for relevant sharing of information amongst agencies in Nigeria. This information sharing will in turn provide a safer environment, one with more accountability to enable better tracking of individuals. Insurgency and other vices that result in insecurity would be curbed with necessary biometric data of individuals collected and used in investigative purposes.

The era of ICT brought a lot of opportunities which negligence on the part of the people and government has paid a big role in not tapping from; to the people a lot of public sensitisation should be put out to create awareness on what really this new technologies bring and its advantages. On the part of the government a commitment to ensuring that this sensitisation is carried out in the most public friendly manner and not imposed on them, because it is important for the citizenry to participate wilfully. The use of IoT oriented infrastructure to give relevant feedback for proper data recording, like in the case of an offender this sort of innovation should be welcomed, so that certain civil disobedience and vices like whenever an individual neglects a traffic law or sign a CCTV camera can be pick the details of the individual ready to be downloaded for further actions by the relevant agencies involved in prompting quick response to such crime scenes.

IoT in the built environment has led to innovations in designs and a city should run as a smart buildings would, smart signage that give individuals information on traffic are some of the innovations that yield in improved fluidity in navigating around the cities with high population and traffic. This paper calls on a national adoption and pro-activeness in the aspect of ICT adoption in urban development in the country, as the country faces a rapid growth of population in many parts while also experiencing a slow growth in Infrastructure.

The SDG deadline approaches and it should be the responsibility of every individual or company operating within Nigeria or Africa to adopt sustainable practices and sustainable design. Professionals in the built environment need to be more vocal and practical about their design decisions, the activity of one person should not cause discomfort to another person or worst make an inhabitable environment for future generation, from the drawing board the topic of sustainability should not be an option, where if a designer is making his design decisions, he may or may not decide to adopt sustainable design measures, it should be a mandatory action of every designer, from conceptualisation to material selection and construction methods.

There is also a need for a transition into a circular economy to reduces wastage and promote recycling, Nigeria already has a lot of local recyclers who have taken it upon themselves to locally gather and recycle materials however, the introduction of ICT and providing smart bins opens the world of recycling to every location where a smart bin can be placed leading to a more effective circular economy which would in turn make safer ocean habitats and reduce drainage blockage which causes flooding.

In conclusion, the study features a comparative review of articles in Fig. 3.2 to arrive at themes that guide easy adoption of a smart city model, the findings of this research has opened more research possibilities in line with this study. It has also revealed that in taking the smart city agenda more serious it ensures a more effective and sustainable environment, observing the kinds of crisis Nigeria goes through whether it be in the health, economy or its territorial integrity a problem of security has been a reoccurring issue. The comparative study in this research reveal similar challenges in other countries and proffers solution in addressing some security challenges as is discussed in the research discussion. It would be beneficial to the Nigeria if the government and Africa as a whole shows more interest in preparing for a future

with a high population and the intricacies of not preparing for it. With the appropriate infrastructure and sensitisation put in place the road to a more sustainable future for cities with high population becomes clearer, however it is not late if proactive measures are put in place now before the government is left with a reactive management crises of population growth. Furthermore, the findings of this study suggest that a city is truly smart when it is able to capitalize, harness and harmonize all its resources through a sustainable approach.

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Appraisal of Landscape Elements within the Hospital Environment in Lokoja, Nigeria

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Abstract
The primary mandate of a hospital is to provide medical care and facilitate healing for the sick person or guide against sickness. In achieving these responsibilities of medical care provision and healing, holistic approach to hospital setting is required. Plants in form of Therapeutic gardens are very critical components of hospital setting which researchers have affirmed to contribute to aiding healing if purposefully integrated into hospital environment. However, in developing countries particularly in Nigeria, integration of plants receives little or no attention both in the hospital design and its implementation. In situations where greenery is provided, it is either that they were under provided or wrong choice of plants were deployed or both circumstances occurred. This has contributed into healing and recovery retardation of sick ones. Therefore, to ascertain the level landscape elements integration, the paper focused on the appraisal of the landscape elements in the existing government hospital in Lokoja. The assessment is done through case studies analysis using physical observations and interview as the tools for data collection. Thematic analysis was used to code was used for the interview data analysis and evaluation. More awareness on the health benefit of healing landscape architecture is necessary. In achieving the essence of hospital, there is the need to do more on design and its implementation of soft landscape elements into the hospital environment.

Keywords: Appraisal, Plants Landscape, Restorative gardens, Hospital, Environments.

INTRODUCTION

As disease outbreak continues to ravage the world, researchers on all fronts have begun to beam searchlights on the best way possible to further improve on the healthcare environment as an attempt to aid the hospital surroundings in contributing to healthcare delivery. Researchers have previously established a strong positive impact on people when connected with nature via the provision of purposeful therapeutic gardens and general planting structure in a unique arrangement (Ulrich, 1999; Ulrich and Parsons, 1992). Proofs attributing extensive array of health profit to human beings when made to come in touch with scenery for people of all ages and in all manner of mental and physical health or illness abound (Kaplan and Kaplan, 1990).

One of the most conspicuous and perhaps the friendliest elements of hospital landscape are plants. In developing Countries and particularly in Nigeria, attentions for landscape elements provision particularly soft landscape elements like greenery are still very low. Instances where they are provided, considerations for standard in terms of hard to soft landscape ratio and the very species of plants required are compromised. Therefore, this paper is focused on assessing the existing government hospital in Lokoja to appraise the extent of landscape elements integration and compliance with the standard and global best practices.

"The provision of greenery in and around the hospital facility should be considered as critical as the hospital building itself". This is to neutralize the enormous attention and resources concentrated at the building structure and most often undermined the relevance of landscaping component of the hospital settings. The roles of these two components are unarguably complementary in realizing the core mandate of the hospital.

Hospital landscaping is principally the provision of gardens and green environments in and around the hospital premises. This is usually designed to overcome stress and improve health care delivery. The positive impact of exposing human beings to nature (indoor and outdoor) cannot be overemphasis, this includes; hormonal stability, alleviation of stress, adequate

restoration, better sleep model and reduction in aggressiveness and agitation (Barnes, 1996; Betrabet,1996; Francis and Cooper-Marcus, 1992;Garlach-Spriggs et al., 1998).

Ulrich, (1984) took it further on the specific benefit of coming in contact with nature. He opined that creating a window of viewing natural environment aid the recovery of convalescent. Arrangement of plants in form of therapeutic gardens and healing plants stimulate huge health outcome (Ulrich and Parsons, 1992; Ulrich, 1999; Wilson, 1992; Yamane el al., 2006).

Plants species which possess medicinal qualities are referred to as healing plants. According to Bonnie (2021), herbs with such characteristic have been largely planted in and around the hospital. This is due to the time proven capacities to cure diseases. Landscaping hospital indoor and outdoor environment with such plants goes beyond just aesthetic but most importantly healing (Micheal, 2019). "Hospital landscaping is not just pretty. It help heals". Plants have helped with healing for decades and some of the plants that worked back then are just as beneficial now. Fill flower bed with Roses, lavender and catnip, Tuck rosemary, Chamomile flower, Gerbera Daisy flower, Jasmine, sage and marjoram into pots where passerby can perceive the flagrance or possibly roughen with skin can stimulate restoration.

Qualities of Effective Restorative Gardens

There are basic characteristics that should be possessed by any functional restorative gardens. This is summarily put as features or a phenomenon that does not promotes stress within the hospital environment. These include; the creation of park-like gardens with grasses and scattered tress, creation of an environment with less concrete rather more greens and flowers, visible wildlife experience, water with gentle slow less noise, less mechanical noisy space and avoidance of crowded environment that is capable of creating insecurity for the patience. Restorative gardens must not possess display of ambiguous artwork and smoking of cigarette must be prohibited (Ulrich, 1999; Ulrich, 1991; Hefferman et al., 1995; Cooper-Mercus and Barnes, 1995, p.55; Whitehouse et al., 2001).

METHODOLOGY

Case study method was adopted through visit to the existing government hospitals in Lokoja for physical assessment of the landscape components of the hospital. In doing this, physical observations through a checklist that focused on the research questions were used. Interview was conducted using structured open ended questions as guide. The sample population was randomly selected within the hospital premises at the peak hour. This was carried out on the hospital users including the workers in order to establish their view point on the existing soft landscape elements. Based on the observations, ratings were assigned to the variables and thematic analysis was used to code the interview responses. The results were discussed; conclusions and recommendations were drawn from the data analysis.

FINDINGS AND DISCUSSIONS

Case Studies: Kogi State Specialist Hospital and Federal Medical Centre, Lokoja

Kogi state specialist hospital was established and constructed by the then government of Alh. Ibrahim Idris to cater for the medical health need of the people. It is located at the heart of Lokoja behind the Adankolo campus of Federal University, Lokoja along Okene/Lokoja road near the popular Ganaja junction. The facility was commissioned by Dr. Goodluck Jonathan in 2010.

It has a general landscape type and of English landscape style, the climate of the area is mild temperate. The hospital has no purposeful landscape design. The topography is relatively flat. The facility is constrained by space having surrounded by rocks to the right, major township road to the front and a feeder road by the left.

The Federal Medical Centre, Lokoja is the only tertiary health institution in Lokoja. It is located at No.1, Salihu Ibrahim way near the popular Nigeria Postal agency office. It is at the centre of the city for easy accessibility for all.

It is on a large expanse of land compare to the state specialist hospital though it is also surrounded by development with no possible future expansion beyond its current perimeter fence. It has undulated topography with mild temperate climate. The environment is occupied by buildings with few landscape elements on sight. The plant landscape elements appeared faltering. The existing lawn and trees were not maintained and there was evidence surface erosion in some part of the premises.

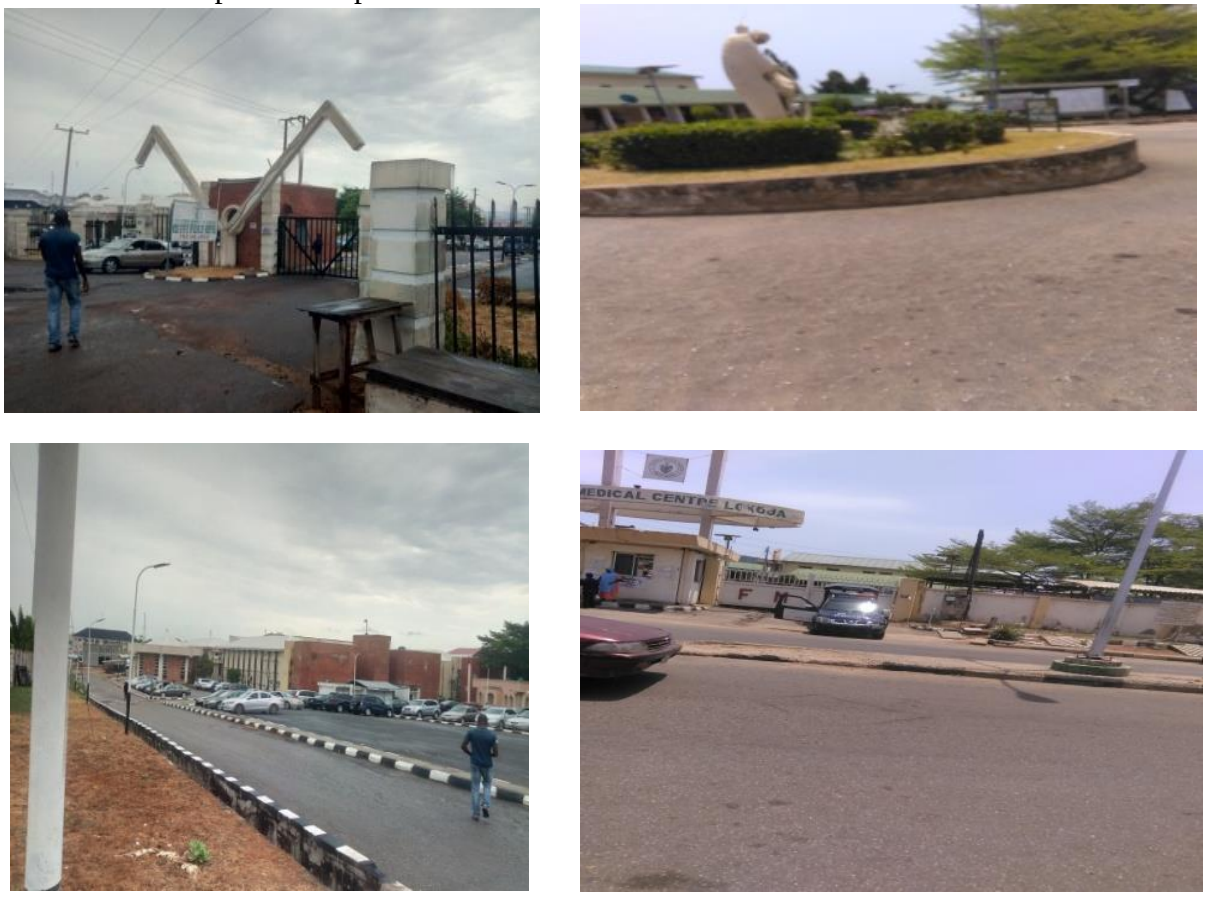

Fig.1. pictures of some views from the two hospital visited

Table 1: Summary of findings of Kogi State specialist hospital and Federal Medical Centre, Lokoja, Nigeria

Variables	**Kogi State Specialist Hospital, Lokoja**		**Federal Medical Centre, Lokoja**	
	Weight Factor	**Remarks**	**Weight Factor**	**Remarks**
Landscape Architectural Expression	4	High	3	Moderate
The species of plants used	2	Fair	2	Fair
Presence of specialized gardens	1	Poor	1	Poor
Availability of indoor plant landscape	2	Fair	2	Fair
Purposeful landscape design and implementation	3	Moderate	2	Fair
The ratio of "softscape" to "hardscape"	3	Moderate	2	Fair

A total of 38 persons were interviewed including 7 medical workers, 13 patients and 18 relatives of the patients in the two government hospital visited in lokoja. The interview was individually conducted, recorded on smart phone and later transcribed. The interview responses were coded using thematic approach to make deductions.

CONCLUSION AND RECOMMENDATIONS

There is a general low awareness in the healing ability of therapeutic landscaping and the need to purposefully integrate them into the hospital environment as a critical component in achieving the hospital mandate.

- The government through her relevant agencies should enforce the existing laws that promote plant landscaping in public buildings
- Policy makers should enact laws that will make compulsory the provision of purposeful therapeutic gardens in the hospitals
- Stakeholders in the health sector and in the built environment must ensure the incorporation of gardens and plants landscaping in the hospital environment
- Hospital managers should ensure that there is deliberate plans to maintain the existing desirable plants components of the hospital
- Advocacy groups to promote plants landscaping in the hospital and raise awareness on the importance of it in the environment.
- More research is needed on the importance of healing landscape and the need to make it a priority in the hospital environment.
- NGOs and donor agencies should sponsor the creation of healing and therapeutic gardens in the existing hospital

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Enhancing the Hospital Environment through Healing and Therapeutic Landscape in Hospital Design

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Abstract
Hospital environment is so important to the overall well-being of the patients. However, unplanned hospital environment that lack the necessary ingredients for healing is capable of sending anxiety into the patients. Furthermore, if the environment is not holistically designed to accommodate some crucial landscape elements to serve as buffer for disquiet and uneasiness the facility risk the chance of achieving her purpose. Therefore, the study seeks to address the problem of inadequate and inappropriate integration of therapeutic gardens and healing landscape in the hospital and its environment through critical review of relevant literatures. Desk research methodology was used in the study. The study reviewed several scholarly articles as well as draw up findings from different authors on the subject matter to arrive at a conclusion. There is so much health benefit from the provision of therapeutic gardens and healing landscape if fully integrated into the hospital environments. Also, recommendations were made in the following areas; (i) Hospital managers and professionals in the built environment should ensure adequate integration of therapeutic gardens and healing landscape elements in the hospital environment (ii) Awareness on the health and economic benefits of human to plant interaction should be raised.

Keywords*: Hospital, Healing, Environment, Therapeutic Garden, Anxiety*

INTRODUCTION
Hospital is a building designed to accommodate people and equipments for the purpose medical treatment and care (Karen, 2009). It is a structure where medical maintenance is sought or an institution where people receive medical, surgical, nursing and Psychiatric care (Encarta, 2009). Therefore, in looking at what hospital entails medical care and nursing is very key. According to International Labour Organization (ILO) report published in 2011, hospital environment is described as a unique community considering array of background that coexist under diverse activities to achieve one aim. The report expressed reservation that if such environment is not properly planned to accommodate the necessary components, the wellbeing, soothe and improvement of the people and equipments might be jeopardize. For the success or otherwise of any living being, environment play significant role, furthermore, Aamarpali, (2017) corroborated that while every institutions or profession need an enhanced environment to thrive, hospital environment needs it more, this is because of the strong connection environment has with its core mandate. She defines hospital environment as the total sum factors that enable the worker to be concentrated on achieving the goal of medical care. In view of the foregoing, it can be concluded that hospital building does not exist in isolation, therefore, for optimum performance of any hospital facility, there is the need to plan the environment to complement the mandate of structure.

In another development, in search of hospital environment that is supportive in achieving the overall goal of setting up hospital, certain elements come to mind. This includes but not limited to therapeutic gardens and other healing elements of landscape architecture.

LITERATURE REVIEW
According to Alao, (2012), over the years healing through gardens has become subject of interest to researchers; this is because evidence has shown that when human beings are systematically connected to plants in form of garden, positive impact is achieved by way of reduction in stress level and anxiety. He posits that as the interest develops, a number of terms emerged. This includes according to him therapeutic horticulture, gardens therapy, therapeutic

gardening to name just few. He continues by saying that, most often, these terms are used interchangeably, however though; there are slight differences between them. In his words, gardens or plants designed to aid healing is summarily referred to as therapeutic garden or healing landscape.

There has been several other scholarly works that attribute a strong positive connection between gardens and recovery process. Ulrich, (1984), through an experiment conducted on patients recovering from surgery concludes that availing opportunity to sick persons to view nature through an opening enhanced the rate of healing and recovery compare to patients that was confine into space without opportunity to experience nature and greenery. However, the author did not state in measureable terms the extent of this recovery and otherwise in the two different scenarios. In a similar experiment carried out by (Wilson, 1972) which supports the previous author asserts that connecting people with green nature improves their medical wellbeing. In his words "more than twice as many patients in the windowless intensive care unit developed post-operative delirium and also a greater incidence of post-operative delirium". He also argued that the increase in the frequency of delirium was as a result of absence of window or opening to connect to the outdoor nature.

In a similar development, research have shown how strolling in the woods, sitting on a park bench and even watching the natural movement of plants and greenery helps to activate and connect the senses Kaplan, (1973). It encourages physical exercise, interactions, stress reduction and elicit positive physiological and psychological reaction.

Justification

There are a numbers of reliable literature works that established a more speedy healing processes if human beings are made to interact and connect with therapeutic and healing landscape.

Research question

To what extent has the inadequate and inappropriate provision of therapeutic gardens and healing landscape affects the performance of the hospitals?

METHODOLOGY

The methodology employed in this study is known as desk research method. Desk research method which is also known as secondary research methodology involve the use of already existing data on the subject matter were summarized and collated to increase the overall effectiveness of the research/study. These documents were made available in the public libraries, relevant websites, relevant internet sources and website. Data obtained from already filled survey. Also, published reports and statistics were important sources that were used in the study.

Conceptual framework

Scholarly articles reveal that theoretical frame work is the structure that hold or support a theory of a research study. This section introduces and describe the design consideration that focus on enhancing the hospital environment through healing and therapeutic landscape. This was achieved by identifying the problem of inadequate and inappropriate landscape elements of therapeutic gardens and healing component, propagate the idea for possible solution, collect data from variable sources which in this case through secondary sources, evaluate the sample data and conclude the results.

Problem Identification

Despite these positive impacts elucidated in access to nature through therapeutic gardens, there has been less attention in providing adequate and appropriate landscape features (outdoors) in

health care facilities (Ariane, 2003), according to him, there has been inadequate provision of outdoor spaces like comfortable seating, safe walking surfaces and inadequate green areas. Intrinsic feelings reveal that being immersed in nature creates better feelings for human beings (Marcus and Saches, 2013).

According to 2014 guidelines for design and construction of health care facilities, access to nature is one of the eight (8) key items enlisted as component for consideration in the physical environment.

SOLUTION/REMEDIES

- **Healing gardens**

There have been traces of meditative environment for the purpose of healing and recuperation since medieval period (Gerlach, 2007).They have been visible in hospitals, hospices and even in many rehabilitation centre. These gardens so structured to instigate and provoke activities which could either be passive or active. The activities but not limited to view through the window, strolling, meditation, exercising and sporting, children play and so on (Marcus, 2007). The gardens are potent for stress relief, relieving of physical symptoms and enhancing the feelings of wellness of the hospital users.

Figure 2: Pictures showing various Therapeutic Gardens at Royal Hospital and Nuffield Orthopaedic Hospital, UK. Source: Internet

In the design and installation of healing gardens, certain principles are very key to adhere strictly.

- **Aid feelings of control**

Healing garden should be made accessible without necessarily being through fenestration. This can be achieved purposeful planning and design. This will widen the chances of user's selection. Considerations for sense organ as concept may be desirable

- **Greening large portion of the area.**

Soft landscape elements like plants are very prominent and key elements in greening the environment. Deployment of trees, shrubs, flowers must be given more space in the planning. The ratio of "softscape" to "hardscape" should be 70% to 30% (Frankling, 2012).

- **Promoting exercise**

Architects and landscape planners have the responsibility to provide walkways, open space to promote exercise like playing, strolling and walking. Exercise keep the body fit and enhance physiotherapy.

- **Create positive distraction**

Evidence abound that stress is wade off when human beings are made to dwell around the plant dominated environment. Gardening enhances mental and spiritual wellbeing. At Great Ormond child and adolescent mental health unit, growing plant has revealed positive impact on people eating disorder. Also at London's Bow centre, flowers and gardens exhibit therapeutic

characteristics (Shackell and Walter, 2012). This model can be explored to regulate distraction while the therapeutic properties are tapped.

- **Avoid intrusion**

Gardens that are designed to prevent disturbance like pollution, of any kinds, artificial lighting. Garden should be naturally structured in a way to stimulate people naturally. Flowers with strong scent are discouraged in order not to affect chemotherapy patients.

- **Minimize ambiguity**

The use of art work that require deeper thinking to decode the meaning is not desirable, this is because such deeper meditation cause stress to the brain, therefore art work of direct expression is required in therapeutic garden.

- **Meditative Gardens**

This type of garden is design with small size, secluded and a quiet serene environment. The design is to take one patient at a time. The principle is to help patient focus on one designed attractive point of activity thereby induced them to relax their mind and consequently aid the healing process. It is a space design for meditation and relaxation of the mind. Meditation gardens are usually purposeful design in a simple manner. The layout is a combination of simple forms which includes circle and square. Circle represents life and square means order (Marcus & Barnes, 1995). They usually have features like water fountain, lawn and comfortable seating arrangement for focal point, all these features are to encourage and promote meditation. Usually, the vegetation should not be bright rather cool colour like green, blue and so on (Furgeson, 2003).

- **Viewing Gardens**

This is a garden design purposely for seeing but without been able to enter it, this is due to limited resources, both in space available and economy. Flowers, green features and water resources are sheltered indoor, this prevents direct touch, smelled or heard.

- **Viewing/Walk-in Gardens**

The differences between this and the viewing gardens is that one can access the garden resources through a lobby or ante room where people will be taken turns to enter the small room. There limitation in terms of space resources and the seating. The design is such that, it does not obstruct the adjourning rooms/offices and also provide interesting viewing opportunity for the people waiting and those that walk around the corridor. There might be a feel of lack of privacy by the users as they are watched by the people (Marcus & Barnes, 1995).

Pictures showing landscaping hospital and health centre.
Source: Internet

- **Edible Gardens**

In an approach to take healing garden to the next level, interactions of herbs, fruits plants and vegetable are planted alongside other convectional landscaping plants and flowers with easy access. The design is such that, it's simple, with path ways, demarcations and in repeated patterns. The public and private are separated (Parcell, 2012). The choice of vegetation is

annually as against perennial plants. Plants like Nasturtium spp with edible beautiful flowers are usually favoured.

Characteristics of Therapeutic Gardens

There have been increased awareness on the need incorporating therapeutic gardens into our health care settings. Cardinal to this, is the efforts to harness the potential benefits of the correlation between physical design and programme intended towards taking the advantages of therapeutic gardens by the visitors and users of the gardens

It has therefore become expedient to establish the cardinal ingredients of the purpose of design and recognition. Attempt to establish the characteristics therapeutic gardens occurred in 1993 by an American Horticultural Therapy Association (AHTA) work team. This was done based on international best practices and evidence based design principles. Recently, American society of Landscape Architects (ASLA) and other related professions have made efforts too to perfect this attempt by establishing the basic elements for therapeutic landscapes. Over times particularly in America, the document has been approved and serves as guiding document in establishing therapeutic gardens. The following element must be visible in therapeutic gardens.

1. **Scheduled and programmed activities:** A horticultural therapy programme installs to support and encourage activities and worthy experience in the gardens is important. However, gardens designed for passive/independent enjoyment by visitors, special events increasing the number of visits, lectures encouraging regular garden task and publicizing activities of all kinds familiarize special population, facility staff, and families of clients/patients/residents and nearby community residents with the garden.
2. **Features Modified to improve accessibility:** Gardens elements, features and equipment are so chosen or modified to guarantee access to places, tasks and memorable feelings to the extent possible. Every steps of modification is geared towards enhancing the therapeutic garden environment that will ease the task of gardening and horticultural experiences for the users. This can encourage the visitor's or gardener to touch or even smell the flowers.
3. **Well defined perimeter:** Edges of the garden environment and some reserved areas for certain activities must be well defined to ensure attention focused by the visitors to the garden. Visitors must be guided not to derail due to absence of the guide by the gardens design.
4. **A Profusion of plants and people/plants interactions:** Therapeutic gardens should connect people with natural environment through plants features by deliberately planned intensive outdoor features for the purpose of restoration, horticultural enlightenment, therapy and social interactions. It should create plant dominated open spaces with path ways and work places. The gardens should promote sensory stimulation.
5. **Benign and supportive conditions:** therapeutic gardens should provide a safe, secure and comfortable environment for the users. Efforts must be made to avoid the use and existence of hazardous substances like the herbicides, fertilizer and insecticides. On the other hand concerted effort must be made to provide comfort through provision of shades, protective therapeutic plants that offer comfort and refuge for the garden users.
6. **Universal designs:** The design of therapeutic garden should focus on convenience and pleasure of wide range of people and conditions. The design should be for all ages, culture and backgrounds. It should be a pleasurable landscape for all. The garden should fulfill its ability to stimulate memory, healing, touch, smell and sometimes taste. It should be able to exploit the most complete range of people/plants interactions and experience possible within its enclosure.
7. **Recognizable Place making:** Therapeutic garden should be simple, complete and easily comprehended places. It should be easily recognized for the purpose is meant to serve, this will enhance the place making role. This is an important strategy in all landscape design, there

should be heighten efforts for visitors to focus on plants-people sensuality, comfort and independent experience within the therapeutic garden.

Finally, it is important for medical professionals and landscape architects and other allied professionals and students alike to understand the characteristics of therapeutic garden and its design principle, considering the cardinal roles played by the garden in our health care environment and the general well being of the users. Understanding the characteristics of therapeutic garden will also enable the successful design and installation of an effective therapeutic garden.

CONCLUSIONS

Having x-rayed the concept of healing environment and therapeutic garden with focus on the principle and its significance in the health care delivery particularly its ability to aid healing and the recovery process of the sick, it suffice to mention that huge benefits abound if concerted efforts are made to tap from the healing properties of the garden. Therefore the following recommendations are made:

i. In most of the developing countries particularly in Africa there have been low awareness about the importance of therapeutic garden and the need to incorporate in our health care setting, therefore awareness must be stepped up in order to gain the benefits of therapeutic gardens.

ii. There should be deliberate policy framework by the policy makers to enact laws and policies that will mandate the incorporation of incorporation of therapeutic garden as critical components of health care settings. Budgetary provision must be statutorily provided to cater for such gardens.

iii. Existing hospitals and other health care facilities that has less space allocation for landscaping features particularly the therapeutic gardens should be upgraded by way of retrofitting and greening of the facilities.

iv. Open space should be identified and developed into landscape facilities within the health care setting.

v. More research into the subject of therapeutic garden is necessary so as to enlighten and enrich hospital design.

vi. The research recommends that landscape courses should be more incorporated into the curriculum of architecture.

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Prospects and Challenges of Urban Agricultural Practices in Katsina City, Katsina State, Nigeria

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Abstract:
This study examined the prospects and challenges of urban agricultural (UA) practices in Katsina metropolis. A multi-stage sampling technique was used to collect data across the five wards of the metropolis. Snowballing technique was used for the administration of questionnaire to 296 urban farmers. Quantitatively, data on access to market channels, labour, credit facility, extension services, and income were collected and analysed using descriptive statistics. On the other hand, interviews were conducted with one staff each from Bank of Agriculture (BOA) and Katsina Agricultural and Rural Development Authority (KTARDA). The study established that all the requirements for UA are met by the urban farmers except extension services and credit facilities that are inaccessible to the all and 56.5% of the practitioners respectively. Nevertheless, there is adequate labour and market to run the operation of UA but this is constrained by water scarcity and limited financial aids. Findings also discovered that UA contributes up to 94% of the total households' income. The average income accrued from poultry, fish farming and rain fed agriculture is above the (UN) poverty baseline of 1.90-dollar per day (₦665). Only the irrigation farmers were earning below the baseline i.e. ₦445 per day. The study suggests that UA should be supported through enabling laws since it can be used to increase revenue base. Indeed, this could also aid in addressing the issues of water scarcity and agricultural extension services.

***Keywords**: Urban Agriculture, Income, Poverty Alleviation, Employment Creation, Sustainability*

INTRODUCTION

Urbanization is an indispensable phenomenon for urban development. Growth of urban centres is often associated with increasing demand for food due to population growth, ecological degradation and urban poverty (Beatly, 2000). Researchers have argued that towns and cities are the sources of these problems as well as their solutions (DECS, 2010). Urban agriculture (UA) is thus an alternative strategy for reducing the effects of food insecurity, unemployment, and poverty that are persistently evident in urban areas. However, the success of agriculture in an urban environment is determined by the enabling environment that drives its practices. Petra *et.al* (2000) asserts that access to extension service; land, water, labour, market channels, farm inputs, and credit facilities are the key requirements for UA.

The contemporary urban development challenges such as those associated with climate change and urban heat island aids in the realization of the potentials of UA in providing carbon sinks and a source of food supply to urban dwellers. In this regard, Ragilo *et.al* (2014) posits that UA is the possible alternative to relieve the pressure of urbanisation, such as employment creation, complementing food supply from rural to urban areas, reducing heat effect and temperature control. Therefore, examining the prospects and challenges of UA in Katsina metropolis is a significant stride in improving the understanding of its potentials, particularly in supporting the livelihood and food security of urban areas. This paper addresses 3 questions: (1) what is it that characterises urban farmers in Katsina? (2) what are the enabling conditions for UA in Katsina? (3) what are the potentials and key challenges facing UA in the city of Katsina?

REVIEW OF LITERATURE

A reasonable amount of literature attempted an isolation of the requirements for UA practice and its potential benefits to cities. The authors include among others, Salau & Attah (2012), Lynch (2014) and Holloran (2013). It was equally opined by Lynch (2014) that the drawback to UA practices in some cities is related to poor extension services, inaccessible credit facilities and high cost of labour. Holloran (2013) identified the lack of titles to land and access to farm inputs as the key limiting factors to UA practice in Dar-es Salaam. Also, these are similar to the factors identified by Lynch (2014). Report on Agricultural Restoration Project in Katsina State in 2015 showed that Katsina state ministry of agriculture and its relevant sectors are vested with the responsibility to render to the farmers the required extension services, provide credit facilities, farm inputs, and marketing infrastructure. These farmers include those operating in the urban realm.

Access to credit facilities, land, extension services, input, market channels, labour, and water are thus considered to be the key requirements in order for UA to flourish in an area. Therefore, these indices were considered as assessment variables for this study. These equally constitute the basic requirements for UA as outlined in the guidelines for urban agriculture development by the Ministry of Agriculture and Cooperatives in Dar es Salaam and Freiburg in 2000 (Petra *et.al*, 2000).

The study area

Katsina city is located at the extreme northern margin of Nigeria. It covers a total land area of about 3,370 square kilometres and it is the capital city of Katsina State. It lies between 11°00' N, 6°45'E and 13° 25'N, 9°05'E. It is defined by a 20km radius from the emirate council at Kofar Soro and is well connected by roads and with other regions (see figure 1).

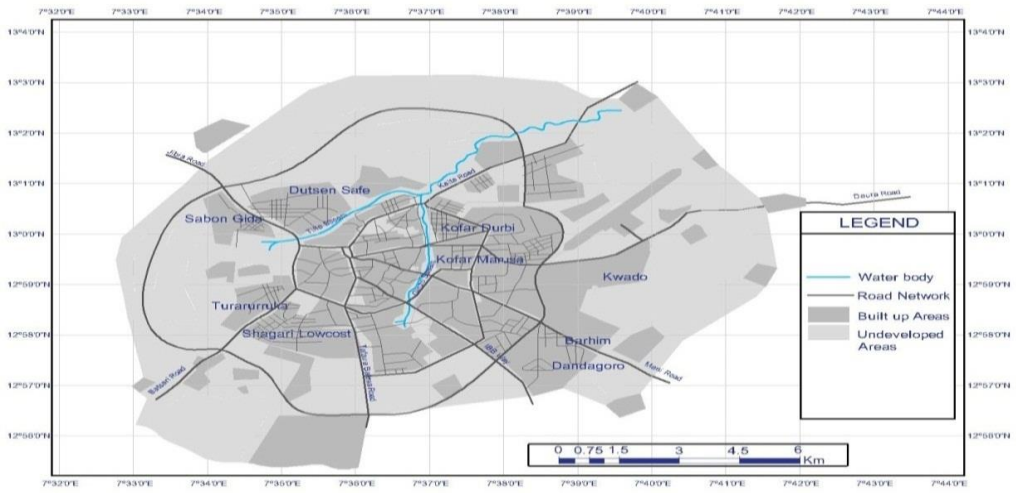


Fig 1: Katsina Metropolis

METHODOLOGY

The target population for this study was the urban farmers within the five wards of Katsina city. Farmers were thus purposively sampled following a pilot study. Quantitative data were collected through the use of questionnaires which was supplemented with field observation. A total of 296 farmers were sampled using cluster sampling from the five wards of Katsina. Snowball technique was used in the administration of questionnaire. The data collected include urban farmers' socio-economic characteristics, farming characteristics of urban farmers, support and services rendered to urban farmers and restraining forces to urban agricultural practices. Furthermore, interviews were also conducted with one staff each from Bank of

the support and services rendered to urban farmers.

RESULT AND DISCUSSION

In this section, the age of urban farmers, farmers' education attainments, occupation, and nonfarm employment conditions are discussed.

Socio-Economic Characteristics of Urban Farmers in Katsina City

In figure 2, we can see that the majority of the urban farmers (27.7 %) are between the ages of 36-43 years. It has also been established that 32% and 30% of the urban farmers acquired secondary and tertiary education respectively, only 23.6% of the farmers had no formal education. This implies the abundance of educated farmers in UA (see figure 3). Majority of the urban farmers had other occupations a part from the UA practice, about one fourth (25.7%) are civil servants, 33.1% are traders. Only 11.5% had no other occupation apart from UA. This is illustrated in figure 4. As regards to nonfarm income, 33.1 % of the urban farmers are earning below ₦10,000 as nonfarm income. Only 11.5% earned up to ₦68,000 as displayed in figure 5.

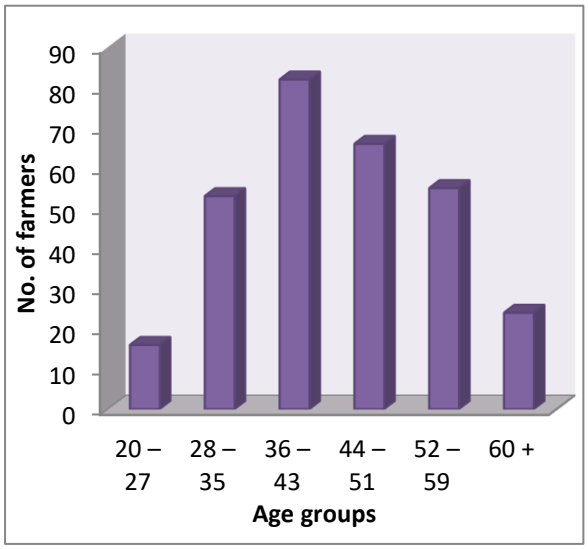


Figure 2: Age of urban farmers

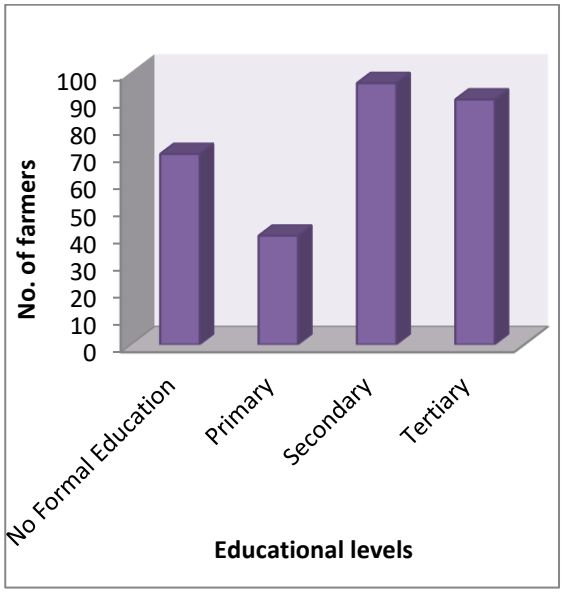
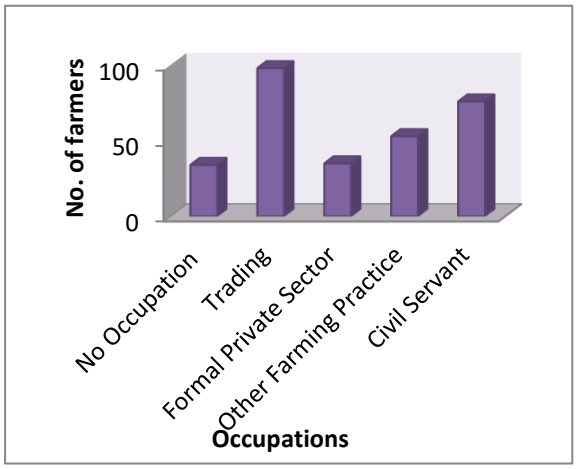
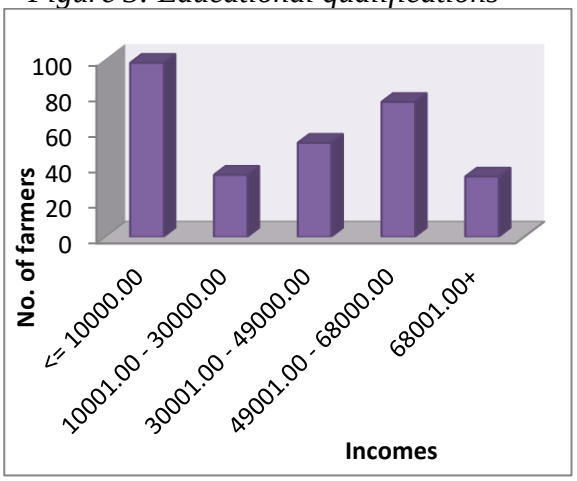


Figure 3: Educational qualifications





Enabling Conditions for UA Practices in Katsina City

The basic conditions for carrying out UA as identified earlier are access to credit facilities, extension services, input, water, market channels, and labour. This is discussed in the sections that follow:

Requirements to access loan from Bank of Agriculture (BOA) in Katsina metropolis

- Applicants must possess account number
- For a matured account, it will take 30 days before the disbursement of the loan
- For an immature account, the disbursement will take about 3 months.
- A beneficiary must possess and present voters' card/driving license, 2 passports and 2 witnesses.
- The beneficiary must be well-known by the bank agent through tracking of his movement and activities for some time.
- In the case of failure to reimburse the money on time, a 3-month extension is given.
- If the condition is still not met, those beneficiaries that used collateral asset as guarantor, their property are valued and auctioned to reimburse the debt.

It was discovered that majority of the irrigation farmers (90.9 %) and rainfed farmers (43.2%) do not possess bank account. Nearly all the poultry and aquaculture farmers possessed a bank account (94.2% and 100% respectively). However, all urban farmers possessed the voters' cards. This implies that the tracking tools used by BoA to familiarise with the urban farmers before giving them loan are not met by the majority of farmers in the city. This signifies the low level of utilisation of Agric loan among the urban farmers (see Table 1).

Table 1 Requirement Attained by the Urban Farmers in Katsina city for acquiring Agric Loan

Bank Account ownership	Irrigated UA		Poultry UA		Rain-Fed UA		Aquaculture UA	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Yes	7	9	31	88.6	124	56.8	5	100
No	70	90.9	41	11.4	94	43.2	0	0
Total	77	100%	35	100%	218	100%	5	100%
Voters card ownership								
Yes	56	72.7	33	94.2	169	77.5	5	100
No	21	27.2	2	57	49	22.5	0	0
Total	77	100%	35	100%	218	100%	5	100%

Access to Extension Services by Urban Farmers

None of the urban farmers had ever been served by an extension agent. This indicates very poor extension services to farmers in the city. From the interview conducted with the extension officer, in the overall, Katsina State has only 3 zones with extension offices with 2 extension agents per zone. Thus, the current ratio of extension agents to farmers was discovered to be above 1:20,000 farmers, this is against the standard ratio of 1:500. This finding disagrees with that of Kahiga, (2013) who asserted that urban farmers largely had adequate contact with extension agents, which is quite untrue in the case of Katsina.

Farm Inputs

Findings showed that urban farmers had access to all the necessary production inputs. Majority of the urban farmers (97.0%) sourced farm inputs from the market. Only 2.7% of the urban

farmers sourced their farm inputs through cooperative associations. This implies the adequacy farm input for production in the city (Figure 6).

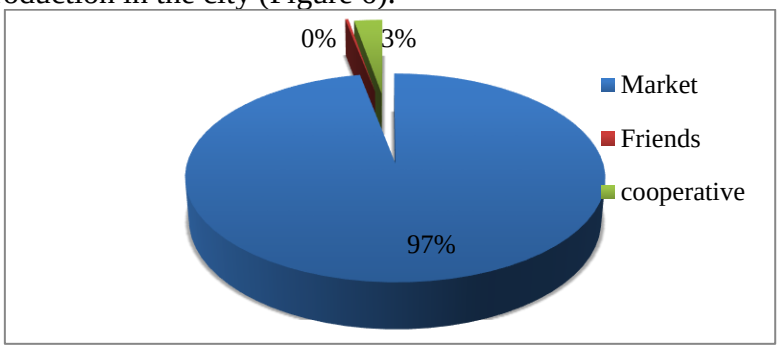


Figure 6: Sources of farm input for urban agriculture in Katsina city

Table 2 shows that 63.9% of respondents relied on rainfall as a source of watering their crops, 12.5% relied on greywater, while 9.8% and 9.1% depended on tap and water vendors respectively. Only 4.7% relied on boreholes. This implies that rainwater is the major source of water for the majority of UA practices. This finding agrees with the assertion of Lynch (2013) who stated that the use of recycled water for irrigation farming is not promising because the quantity of the water for production depends on the level of consumption from the neighbouring households and communities. An example of these sources of water used for irrigation farming is shown in Plate I.

Table 2 Access to Water by Urban Farmers

Water sources	Frequency	Percent
Rainy Water	189	63.9
Taps	29	9.8
Borehole	14	4.7
Water Vendors	27	9.1
Greywater	37	12.5
Total	296	100.0

Plate I: Greywater used for irrigation farming at Kofar Marusa

In the Table, it can be seen that 73.3% of respondents sell their produce to individual consumers, 20.6% sell to middlemen and others, whereas 4.4% sell their produce to restaurants. Only 1.7% of the respondents sell their produce to cooperative members. This means that most of the farmers produce directly to consumers in the city. Perhaps, the demand by individual

Table 3 Categories of Farm Produce Customers

Produce Buyers	Frequency	Percent
Individuals	217	73.3
Restaurant	13	4.4
Member	5	1.7
Middlemen others	61	20.6
Total	296	100.0

Table 4 shows that two-fifth of the urban farmers (40.5%) were using hired human labour, 26.4% were using family labour, while 20.6 were using personal labour. Only 12.5% of the urban farmers were using mechanised labour for the practice. This implies that farming operation in the city predominantly utilises manual labour.

Table 4 Sources of Urban Farm Labour

Labour Types	Frequency	Percent
Hired human labour	120	40.5
Mechanised	37	12.5
Personal labour	61	20.6
Family Labour	78	26.4
Total	296	100.0

Potential and observed impact of UA practices in Katsina City

This section presented the potential and observed impacts of different types of UA practices to income generation, employment creation and poverty alleviation.

Table 5 shows the average income accruable from UA practices in Katsina metropolis. It has been discovered that the average income per harvest of poultry production was ₦ 46,057.1, irrigation farming account for ₦ 29,077.9, whereas fish farming had ₦ 709,125.9. The average income accruable from Rain-fed agriculture is ₦ 200,573.4 per harvest. This implies that, a reasonable income is generated.

Table 5 Average income accruable from the different types of urban agricultural practices in Katsina city

Type of UA	Total income/harvest (₦)	Average income (₦)
Poultry farming	1,612,000	46,057.1
Irrigation farming	2,229,000	29,077.9
Fish farming	5,673,000	709,125.6
Rain-fed farming	43,725,000	200,573.4
Total	₦53,339,000	₦984,833.4

Table 6 shows the relative contributions of UA and non-farm activities to household income in Katsina metropolis. The mean income per harvest of rain-fed agriculture was found to be ₦ 200, 573, 4 accounting for 94% of the total income of the practitioners.

Table 6 Percentage contribution of rain-fed agriculture to households' income in Katsina city

Farmer's income	Total income/harvest/month (₦)	Mean income (₦)	(%) of the Grand total
Urban farming (rain-fed)	4,372,500.00	200,573,4	94%
Nonfarm source	2,862,000.00	10,928.6	6%
Total	₦ 4,658,700.00	₦ 211,497.06	100%

The mean nonfarm income of the urban farmers was ₦ 10, 928.6 representing 6% of the total monthly income of the urban farmers. This means a greater proportion of the income was derived from urban agriculture than nonfarm sources, this might be due to the low-income earnings from the nonfarm activities in the city which makes people take up urban farming as an alternative survival strategy.

The study also established the potential of urban agriculture towards poverty alleviation in Katsina city using the United Nations (UN) poverty baseline (1.90 dollars per day) i.e. ₦665. It was discovered that the income accrued per day from poultry farming, fish farming, and rain-fed agriculture is above ₦ 665 per day. Only the income accrued from irrigation farming was below ₦ 665 per day. This implies that UA could enhance the reduction of urban poverty in the metropolis. However, from urban management perspective, UA could be used as a tool in increasing the city's revenue base (see Table 7).

Table 7 Potential of UA towards Poverty Alleviation in Katsina city

Type of UA	Average income/harvest (₦)	Average days	The income per day (₦)
Poultry farming	₦ 46,057.1	38.5	₦ 1196.2
Irrigation	₦ 29,077.9	59	₦ 492.8
Fish farming	₦ 209,125.6	165	₦ 4297.7
Rain-fed	₦ 200,573.4	210	₦ 1910.2

Management of UA Waste in Katsina City

Figure 7 shows the techniques used by urban farmers in managing UA waste. The majority of the farmers 84% are burning the waste. 10% of the poultry farmers usually dry the waste and packaged it. Only 7% of the practitioners disposed of the waste in landfills. This implies improper waste handling techniques by urban farmers. Indeed, this signifies a symbiosis relationship between crops and poultry farmers through provision of manure.

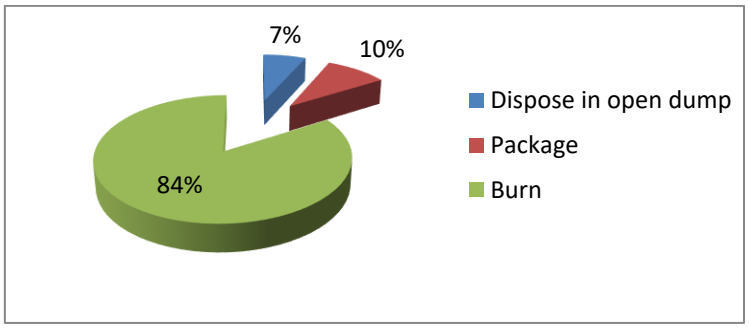


Figure 7: Method used in managing the generated waste from UA

Key constraints facing the UA practices in Katsina City

In line with the enabling conditions for UA discussed earlier. It appeared that the level utilisation of agricultural loan is very low and this was found to be attributed to the requirement attained by the practitioners for acquiring Agric-loan from BoA. It was also discovered that water scarcity has pushed 16.2% of irrigation practices away from the city. The shortage of produce (28.3%) was the key challenge faced in trying to meet up with consumers' demand and this is relatively connected to water scarcity for production. Indeed, limited finance has also been a limiting factor towards the utilisation of the abundant labour for UA in the city.

CONCLUSION

The study established the presence/otherwise of UA requirements in Katsina metropolis. Findings showed that there is abundance of labour, farm inputs, and market to run the UA. But water scarcity and financial aid have become obstacles to the majority of farmers in realising the optimum benefit from the practice. Only the irrigation farmers were found to be below the poverty line. Hence, poultry farmers, rain-fed farmers, and fish farmers are poverty secured because the income accrued from these practices is above ₦665 per day. Therefore, there is the need for proper waste handling, deployment of extension agents, and diversification of sources of irrigation water apart from greywater by adopting closed fields crop cultivation.

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Benefits of Using Green Materials for the Construction of Low-Cost Building in Nigeria

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Abstract:
The earth and recycle materials have been in utilisation for the construction of building at a reasonable price by human being from time immemorial. Conversely, in the resent time the cost of building has increased to the extent that is now beyond the power of lower and middle class to construct or buy building of their own. Therefore, this paper assesses the benefits of using green materials for erection of structure at affordable prices. Four hundred structured survey instrument questionnaires were prepared and distributed through purposive sampling to construction professionals in the north-central part of Nigeria, seeking their views on the benefits of using green materials towards provision of building at reasonable price. The responses received were analysed using analysis of moments structure (AMOS) through structural equation model (SEM). The results show that green material is cost-effective, readily available, energy efficiency, reduced cost of construction, reduced waste, improved the economy of the community promotes cultural heritage, adaptable to the environment, eco-friendly, enhance social wellbeing, and reduced carbon dioxide emission. Consequently, a combination of green materials with conventional materials will promote delivery of more buildings to the citizenry at reasonable cost.

***Keywords**: Green Materials, Affordable price, Building, Benefits, Structural equation model, Nigeria.*

INTRODUCTION

The ambition of people to construct the house of their own or ability to own residential property is very high, but this remains a mirage due to high cost of conventional materials. This problem forms the main reason of carried the research in other to proffer solution through the application of an alternative materials term green materials. There are different forms of the definition of green materials by various scholars, some defined it as sustainable materials that are environmentally friendly while others feel that they are materials that are natural and subjects to reuse and recycle in building construction. According to green building team (2011), green materials refer to sustainable material that gave high performance and save the precious environment.

Fithian and Sheets (2009) said as long as materials have an affirmative effect on the environment that materials could be described as green. Since building with conventional material at affordable rates becomes an issue in recent times, thus re-introducing green materials as alternative material will no doubt ease the flight of low-income earners in the country.

Therefore, green materials are natural and recycled materials such as earth bricks, bamboo, recycle materials and waste, etc. that are readily available within our environment. The socio-economic benefits of these materials were assessed in this paper, and the results of the Structural Equation Model (SEM) were subsequently discussed.

Affordable Building

Building construction cost in the 21st current century remained very high to the extent that it is now difficult for the low and middle-income earners to facilitate or construct building of their own at an affordable rate; as a result of this there is a lot of abundant or uncompleted buildings are within the community across the nation. The perception of building at a reasonable and economical cost is a challenging matter and remains a persistent and extensive difficult for

several nations (Mulliner & Maliene, 2012). Internationally, accommodation affordability is defined in many ways. The most common definition of affordable building is referred to the housing affordability is taken as a measure of spending on construction or buying housing to income of the household (Gopalan & Venkataraman, 2015a). Affordable building as an element that can be afforded by that segment of people whose income is lower than the middle household revenue and it was also defined by Karan and Manish (2016). the Us and Canada defined it as the ability of potential owner to have a building of his own at a cost not more than thirty percent of his income annually.

Esruq-Labin *et al*, (2014) described an inexpensive building as a notion that is used to describe socio-economic and growth environs, that purpose of certifying if building to be developed for people can be achieved at an affordable cost by the target group of people within the low and middle-income earners. According to UNIDO, (2018), there is major problem in the provision of adequate housing to the populace globally. It was revealed that many people across all types of urban centres could not afford to have a building of their own or even afford the cost of paying rent.

In the study carried out by Tajudeen & Basirat (2017), it was discovered that materials and construction methods adopted in accomplishing the building have a significant effect on the expensiveness and unaffordability of building to members of the society. In Malaysia, Osman *et al.*, (2017) established in a study that notwithstanding the existence of inexpensive housing strategy for the State of Johor, housing cost remains at higher cost which makes difficult for majority of the people to achieve the aim of having personal house, and this reflected in the fact that the housing index for some of the area was harshly excessive amounts and mainly tricky for the people of the state to accommodate.

Green Building Materials

The building materials are one of the significant components in the construction industry that determines the overall total cost of constructing building as it constitutes the most substantial single input in executing a project (Ben, & Chioma, 2015). As a result of the escalated price of the conventional materials, stakeholders in the building industry now suggest alternative materials known as green materials to reduce the overall cost of construction (ManjeSrivastavash & Kumar, 2018, Jasvi & Bera, 2015, Mukiibi, 2015, Jasvi & Bera, 2015). Accordingly, potential green materials are materials that are locally oriented and renewable that are environmentally friendly; they composed of renewable rather than non-renewable resources (Mahmoud, 2016). It was further revealed by Mahmoud (2016) that mixing of the natural materials into the construction of housing could mitigate the effect of the environment problem links with the production, conveyor, processing assembly, construction, recycle, reuse, and discarding of these materials.

In a study, Bredenoord (2017) suggested the following as promising building materials for the construction of affordable housing:

- Bamboo/Timber
- Compressed earth bricks
- Adobe blocks
- Recycle materials
- Improved concrete panel

Figures 1, 2, and 3 show some of the available green materials in Nigeria. Bamboo are materials that are generally available in Nigeria, they are multi purposely use in construction of building at various stage of the building projects, in addition is it tension strength that has been established by materials expert to be more than that of mild steel (Kayode & Olusegun, 2013,

Alade *et al*., 2018). According to Atanda (2015) bamboo is known to be one of the most fasted growth plants in the world and now been considered as a replacement of steel and wood in construction activities.

Timber is also a common material that is used for formwork, support, roof trusses, and scaffolding in building construction process, it is available in various sizes and types (see Figure1) at a reasonable price depending on the specification required (Magutu 2015, Tam, 2011, Odeyale & Adekunle, 2008).

Fig 1: Various sizes of planks

Compressed earth brick is made from selected soil and has been the first building materials since the existence of humans. The technology of compressed earth bricks has, in recent times increased and may be used to produce housing at affordable, durable and robust (Gohnert, Bulovic, & Bradley, 2018). According to Jackson & Dhir (2016), the materials for bricks are readily available, produced in mass and required little or no maintenance with high durability and load-bearing capability.

Figure 2: Earth brick column and walls

Benefits of Green Materials

The benefits of green materials are numerous and readily available in most of the countries across the globe. The introduction of green materials brings the cost of constructing a structure to the barest minimum and more cost-effectiveness as well makes accommodation affordable for more people in society (Ugochukwu & Chioma, 2015). According to Zami, (2008) rammed earth wall is 40% lower than the cost of standard stud wall including labour cost. Zami stressed further that there are other benefits such pleasant comforts and energy efficiency and

unseen ecological benefit like enhance more oxygen to the environment. Oshike, (2015) postulated that green materials such as earth has a comparative environmental advantage over the building constructed of conventional material

Figure 3: Thatches in stock with roof in place

In the study carried out by Danso (2013), obtainability and affordability, among other advantages are some of the significant benefits of using green material in building construction in Ghana. Zami (2008) concludes that the flexibility and simplicity in technology of the usage of green materials promote the transfers of knowledge between the stakeholders in the building industry, individuals and communities at large can easily participate in the activities of constructing their building at an affordable cost.

The summary of the previous study on the benefits of green materials was presented in Table 1.

Table 1: Previous study on the benefit of green materials

No	Author(s)	Objectives of the study	Outcomes of the study
1	Gohnert, Bulovic, & Bradley (2018) South Africa	The need to develop low-cost housing alternatives to make housing more affordable to people	Green materials as an economical solution to the provision of building at affordable cost
2	Danso H. (2013) Ghana	To examine and analyse the benefit and problem of houses constructed with local materials in developing country	Promotion of cultural heritage, readily available, temperature regulation, affordable and cheap
3	Kumar, Gupta, Sagar, Singh, & Haroon, (2017) India	To review the alternative construction materials and techniques for building design	It was established that fly ash brick, one of the green materials is comparatively low cost than the conventional bricks
4	Adegun & Adedeji, (2017) Nigeria	To review the economic and environmental advantages and disadvantages of earthen materials for housing in Nigeria	The earthen construction material discovered to have benefit of cost and cost to the environment.
5	Shen, Yang, Zhang, Shao, & Song, (2019) China	Assessment of bamboo benefit and barrier for promoting bamboo as a green material in china	The benefits of using bamboo are summarised as; low cost, large scale and fast growth, lightweight and high strength, environmentally friendly, and socio benefit.

METHODOLOGY

Survey questionnaire was prepared and distributed to Nigerian Building Construction practitioners. During the conduct of this research, questionnaires were distributed to Nigerian Building Construction professionals; comprising of the Architects, Quantity Surveyors,

Builders and Civil Engineers who were duly registered members of different organizations and practicing in the building construction industry. The questionnaires were distributed to the targeted respondents on purposive bases without been bias. The main merit of the purposive approach is the broad range sampling methods that could be used in all the research design. Therefore, in the six-state two towns were selected as study area per state. The capital of the state and next city to the state capital as specified in Table 2

Table 2: State with towns for data collections

State	**Town A**	**Town B**
Benue	Makurdi	Gboko
Nasarawa	Lafia	Nasarawa
Niger	Minna	Bida
Kogi	Lokoja	Okeene
Kwara	Ilorin	Offa
Plateau	Jos	Bassas

The method adopted in the administration of the questionnaire was to group all the professionals by states, to determine the exact number for each state. Thereafter the number of an expert in each state was calculated as a proportion of total members in the entire north-central geopolitical zone and multiplied by the total number of questionnaires to obtained sample proportion. The questionnaires were then distributed proportionally among the state in accordance to the population of the professionals; Benue 60, Nasarawa 45, Niger 120, Kogi 59, Kwara 65, and Plateau State 51 samples respectively see table 3 for the entire population.

Table 0: Population of the registered professionals in north-central Nigeria

S/N	State	Architecture	Building Engineer	Civil Engineer	Quantity Surveying	Total	No. Per State
1	Benue	55	44	200	64	363	60
2	Nasarawa	45	80	123	20	268	45
3	Niger	80	215	312	120	727	120
4	Kogi	68	65	202	19	354	59
5	Kwara	69	82	180	59	390	65
6	Plateau	42	64	155	48	309	51
	Total	359	550	1172	330	2411	(400)

Source: *NIQS head Office and State chapters of NIA, NIOB, and Civil Engr. respectively (2018).*

Hence, out of the 400-questionnaire distributed in the six different states of the north-central zone of Nigeria (Plateau, Niger, Benue, Nasarawa, Kogi, and Kwara States); after retrievals of the questionnaires, 305 were valid and suitable for the analysis, 40 copies were not properly filled, while 55 copies were not returned as presented in Table 4

Hence, Valid response rate = 305/400*100 = **76.2%**

Table 4: Analysis of respondents

Sample	Number of responses	Percentage %
Non retrieved response	55	13.75%
Unsuitable response	40	10%
Valid and suitable response	305	76.2%

This valid response is considered as the suitable response rate; therefore, the numbers of 305 questionnaires representing 76.2% are considered and adequately suitable for this study. There is no agreed standard of agreement on the level of response rate on a survey questionnaire. The results are accepted as good considering Fowler (2002) study, which indicates that 75% response rate are demanded by some federal funding agencies on the survey instruments as standard. However, Visser, et al., (1996), suggested that the survey with lower rates like 20%

have more accurate measurements than the ones with higher response rate such as 60% and above.

ANALYSIS AND RESULT DISCUSSION

The structural equation model (SEM) used in carrying a confirmatory factor analysis (CFA) of the constructs. The construct which was on benefit (economic viability) of green materials contains 15 indicators that were evaluated in confirmatory factor analysis. The 15 observed variables were derived from two sub-scales in part D of the survey. Figure 4 shows the first measurement model for the benefits of GMs. Table 3 shows the displays for the first measurement model for the benefits of GMs construct.

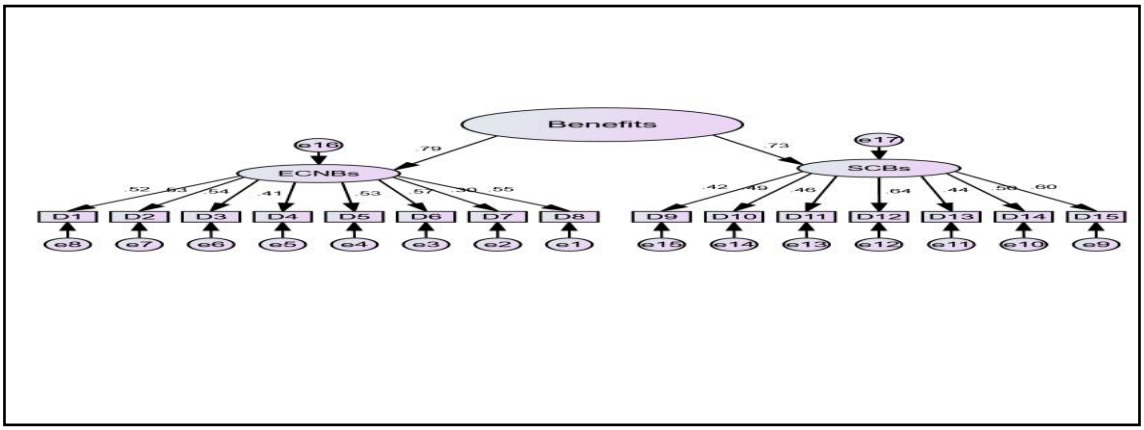

Figure 4: First measurement model for construct on the benefit of GMs

Table 5: Details for the first measurement model for concept on benefit of GMs

Construct	Code	Indicators
Economic Viability of GMs	D1	Cost-effectiveness
	D2	Readily available
	D3	Energy efficiency
	D4	Create jobs for people
	D5	Reduced cost of construction
	D6	Reduced waste
	D7	Aesthetics /beautification
	D8	Improved the economy of the community
	D9	Promote cultural heritage
	D10	Improved occupant productivities
	D11	Adaptability to the environment
	D12	Eco-friendly
	D13	Improved social capital
	D14	Enhance social well being
	D15	Reduced CO2 emission

The parameter of the fitness index, as shown in Figure 4, specifies the poor fit of the measurement model, with values of detailed indices of (ChiSq/df= 2.331 <3.00) and (GFI = 0.916); while AGFI, CFI, TLI and NFI < 0.90), and (RMSEA=0.066 < 0.08). Therefore, the model required modification to accomplish a suitable index. To reach uni-dimensionality for the model, variables that have weak loading factors below 0.5 were deleted. The final measurement model for the construct on the socio-economic benefit of GMs, once low load items exclusion, is shown in Figure 5. The model attains the construct validity with the acceptable Fitness Index of: P-value=0.041, RMSEA=0.046, GFI=0.977, AGFI=0.957, CFI=0.954, TLI=0.93, NFI=0.900 and ChiSq/df= 1.63. Table 4 shows the indicators for the modified measurement model for concept on socio-economic benefit of green materials for affordable housing in Nigeria.

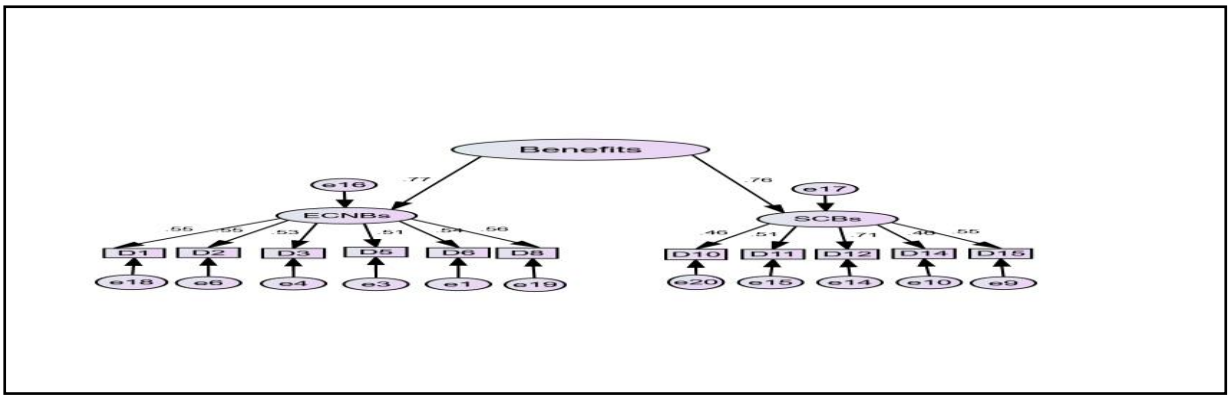

Figure 5: Modified measurement model for construct on Benefits of GMs

Table 6: Details for the Modified measurement model for construct on Socio-Economic benefits of GMs

Construct	Code	Indicators
Economic Viability of GMs	D1	Cost-Effective
	D2	Readily available
	D3	Energy efficiency
	D5	Reduced cost of construction
	D6	Reduced waste
	D8	Improved the economy of the community
	D10	Improved occupant productivities
	D11	Adaptability to the environment
	D12	Eco-friendly
	D14	Enhance social well being
	D15	Reduced CO2 emission

The composite reliability and convergent validity for the model were also realized with a CR value of 1.49, and 0.98 (≥0.6) and an AVE value of 1.80, and 1.44 (≥0.5). Table 5 displays information on the validity and reliability evaluation for the model. From the overall fulfilled values of Fitness Index, uni-dimensionality, validity, and reliability for the measurement model, the model was then recognized to put forward to be part of the final evaluation in the structural equation model.

Table 7: Validity and reliability assessment for benefits of GMs measurement model

Constructs	Items	Factor Loading (≥ 0.5)	AVE (≥ 0.5)	CR (≥ 0.6)
Socio-Economic benefit of GMs	D1	0.55	1.80	1.49
	D2	0.55		
	D3	0.58		
	D4	Deleted		
	D6	0.54		
	D7	Deleted		
	D8	0.56		
	D9	Deleted	1.44	0.98
	D10	0.46		
	D11	0.51		
	D12	0.71		
	D13	Deleted		
	D14	0.46		
	D15	0.55		

Therefore, the analysis reveals the followings; the cost-effectiveness, readily available, energy efficiency, reduce waste, improve the economy of the community, improve occupants' productivity, adaptability to the environment, eco-friendly, enhance social wellbeing and

reduce the emission of carbon dioxide as the benefits of using green materials for the construction of affordable building. This is comparable to the findings of Umar and Khamidi (2012), which discovered that green building practice makes efficient use of natural resources, safeguard occupant health and enhance employee productivity, and reduce waste materials, pollution, and environmental degradation. Social-culturally, this study showed that GMs help promotes cultural heritage, improved occupant productivities, enhance social well-being and reduced CO_2 emission. Evidence by Jaiganesh *et al*., (2016) has established that the use of GMs for the low-cost building has socio-cultural advantages.These outcomes was also comparable to the results obtained by Gohnert, Bulovic, & Bradley (2018), Ugochukwu & Chioma, (2015), Oshike, (2015) and Adegun & Adedeji, (2017) on the advantages of using green materials.

CONCLUSIONS AND RECOMMENDATIONS

This study assessed the benefits of using green materials for the realization of affordable buildings for the average citizen in society. Four hundred questionnaires was prepared and distributed through purposive sampling to the registered building professionals in the north central zone of Nigeria. Analysis of moment structure (AMOS) a statistical analysis was carried out through the structural equation modeling (SEM) on the useable and valid data collected, the finding revealed that there are potential benefits of green materials for the construction of low-cost building. Thus, this study is recommending the re-introduction and use of relevant green materials as construction resources to mitigate the problem of high cost of conventional building materials and subsequently provision of affordable building to the lower income groups in Nigeria.

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