



**FEDERAL UNIVERSITY OF TECHNOLOGY,
MINNA, NIGER STATE, NIGERIA.**
CONFERENCE PROCEEDING OF THE



**INTERNATIONAL CONFERENCE
OF SCHOOL OF INNOVATIVE
TECHNOLOGY**

Theme:

**Innovative Technology:
A Panacea for Sustainable Socio-Economic
Growth and National Development**

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SUSTAINABLE SOCIO-ECONOMIC GROWTH
AND NATIONAL DEVELOPMENT**

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OPTIMUM UTILIZATION OF QUARRY STONE DUST AS PARTIAL REPLACEMENT OF FINE AGGREGATE IN CONCRETE PRODUCTION

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ABSTRACT

This study presents the results of laboratory work carried out to determine the compressive strength of concrete made with quarry stone dust as partial replacement of fine aggregate. The study examined through empirical means the properties of Quarry stone Dust as fine aggregate in concrete. The result of the study showed that its specific gravity and water absorption, showed satisfactory performance. Result of compressive strength of standard cubes made with Quarry stone dust in replacement of river Ohio sand (sharp sand) in 0%, 15%, 30%, 45%, 60% and 100% showed increased strength with mix ratio 1:2:4 and 0.5 water cement ratio. All the mixes used in the study attained over 60% of their 28 days strength at 7 days. Preliminary tests were also carried out to determine some physical/mechanical properties of the materials used, this test include; specific gravity, water absorption, sieve analysis, consistency test, soundness and setting time test, workability test of the concrete are; 45mm, 47mm, 49mm, 50, 52mm and 55mm respectively for various replacement levels. With minimum percentage replacement of QSD of 45% the researcher was able to achieve 24.8 N/mm² strength which is very close to the target strength of 25 N/mm². The highest compressive strength of 28.5 N/mm² was obtained at 100% QSD followed by 26.1 N/mm² at 0% QSD (control). The result suggest that quarry stone dust as fine aggregate in concrete production with a recommendation of 45% quarry dust and 55% sand which gives an optimum compressive strength of 24.8 N/mm².

Key words: Compressive strength, quarry stone dust (QSD), partial replacement, fine aggregates

INTRODUCTION

Concrete is the most popular building material in the world. In recent times, the cost of producing dense concrete has become expensive partly due to the soaring cost of aggregate and the absence of other sources of alternative aggregate. In the face of general increase in building activity and civil engineering construction particularly in the field of reinforced concrete and road construction, the consequent spectacular increase in the consumption of the convention of the natural gravel and crushed rock aggregate is becoming enormous and expensive. These and other reasons have made the construction industry in general and the building and civil engineering industries in particular to consider the gradual utilization of alternative material for construction. River sand has been the most popular choice for the fine aggregate component of concrete in the past, but overuse of the material has led to environmental concern, the depleting of securable river and deposits and a concomitant price increase in material. Therefore, it is desirable to obtain cheap, environmentally friendly substitute for river sand and that are preferable byproducts. (Waziri & Mua'zu, 2008).

According to Hangovanet *al*, 2006, Quarry dust has been proposed as alternative to river sand that gives additional benefits to concrete. Quarry dust is known to increase the strength of concrete over the use of quarry sand as fine aggregate in concrete is expected to affect some properties, such as the compressive strength, durability, strength development, workability and economy.

Moreover, the incorporation of quarry dust as fine aggregate will offset the production cost of concrete in brief, the successful utilization of quarry dust as fine aggregate will turn this dust into valuable resource and the current global emphasis on 'waste for wealth (WFW)', as

well as the environment impact of such waste (quarry dust) has prompted the need for research and development of the waste into useful material (Troxell *et al*, 1968).

Quarry dust is made while blasting, crushing, and screening coarse aggregate. Quarry dust has rough, sharp and angular particles, and as such causes a grain in strength due to better interlocking and a concomitant loss in workability. The use of quarry dust sometimes causes an increase in the quality of cement required to maintain workability.

The quarry dust contained more fines smaller than the 200um sieve than the river sand (about 20% for the quarry compared with 5% for river sand) According to the guidelines for mix design according to the Department of the environment of the United Kingdom, the finer the fine aggregate used in concrete, the higher the requirement of free water to maintain workability. However, the mix-design procedure limits the analysis of fines content of a fine aggregate to % passing 600 um sieves therefore, the guidelines should clearly be used with trial mixes when inserting quarry dust. (B.S 812, 1985). This research is aimed at determining the optimum quarry stone dust to get a better response in terms of the compressive strength of concrete.

MATERIALS AND METHODS

Materials

The materials used in this research include the following:

- i. Cement: commercially available Dangote ordinary Portland cement of grade 42.5R.
- ii. Fine (River Sand): Locally available river sand with a Specific gravity of 2.57
- iii. Quarry Stone Dust (QSD) and Coarse Aggregate: Are sourced from locally available quarry plant in Zaria, Kaduna.
- iv. Water: Clean and portable water sourced from the Department of Civil Engineering Laboratory.

Methods

The methods used in his research include:

- i. Tests for determination of the physical properties of the constituents materials, which includes; consistency and soundness test on the cement, specific gravity test and sieve analysis on the aggregates used.
- ii. Design, batching (by weight) and mixing of concrete: ratio 1:2:4 and W/C of 0.5 were adopted targeting 25 grade concrete. Total number of 120 cubes were cast, 5 cubes for each % replacement (for 3, 7, 14 and 28 days respectively).
- iii. Test for determination of workability of fresh concrete
- iv. Compressive strength test on hardened concrete

RESULTS AND DISCUSSION

Specific Gravity

Table 1 summarizes the results for the average specific gravity of the aggregates and the QSD.

Table 1: Average Specific gravity of the aggregates

Aggregates	Fine	Coarse	QSD
Specific Gravity	2.57	2.92	2.09

It can be seen that QSD has the least specific gravity, leading to light weight concrete compared to the fine aggregate.

Sieve Analysis Result

The result for the particle size distribution for the aggregates used are presented in Fig. 1 to 3 as shown below,

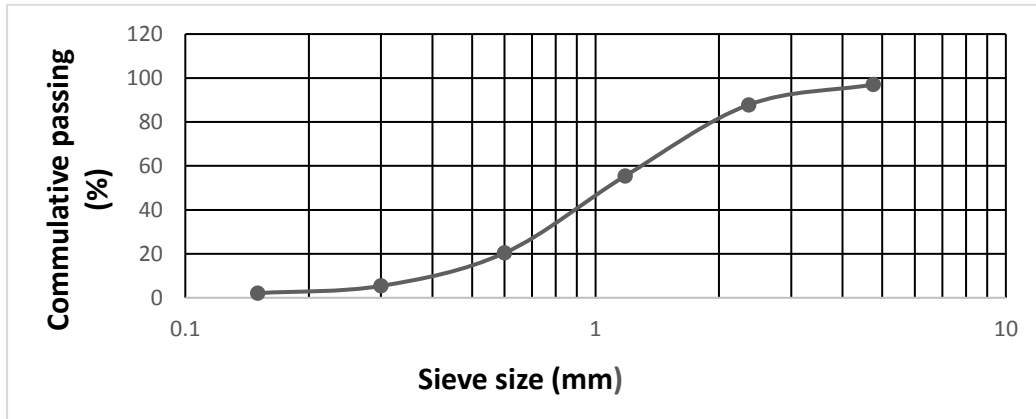


Fig. 1: Particle size distribution for the fine aggregate

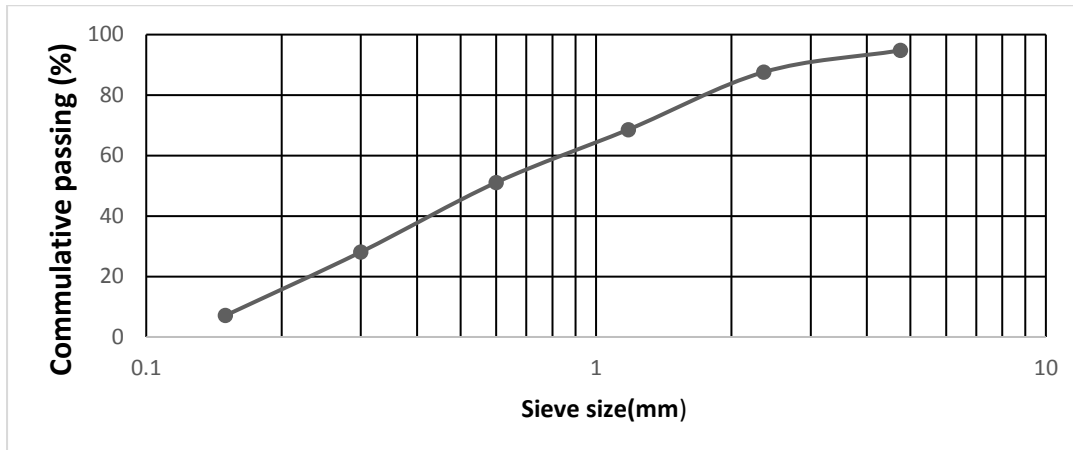


Fig. 2: Particle size distribution for the quarry stone dust

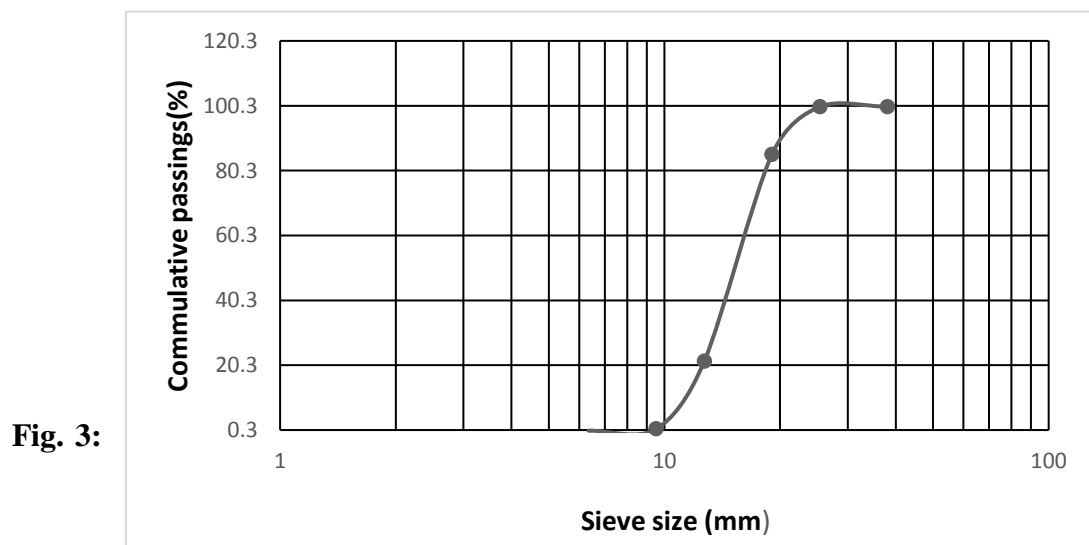


Fig. 3:

Particle size distribution for the coarse aggregate

Determination of concrete Workability

Slum test was use in order to determine the workability of concrete and the result of slump value falls within the range of values for medium workability for all the percentage replacement of fine aggregate with QSD as show in Fig. 4.

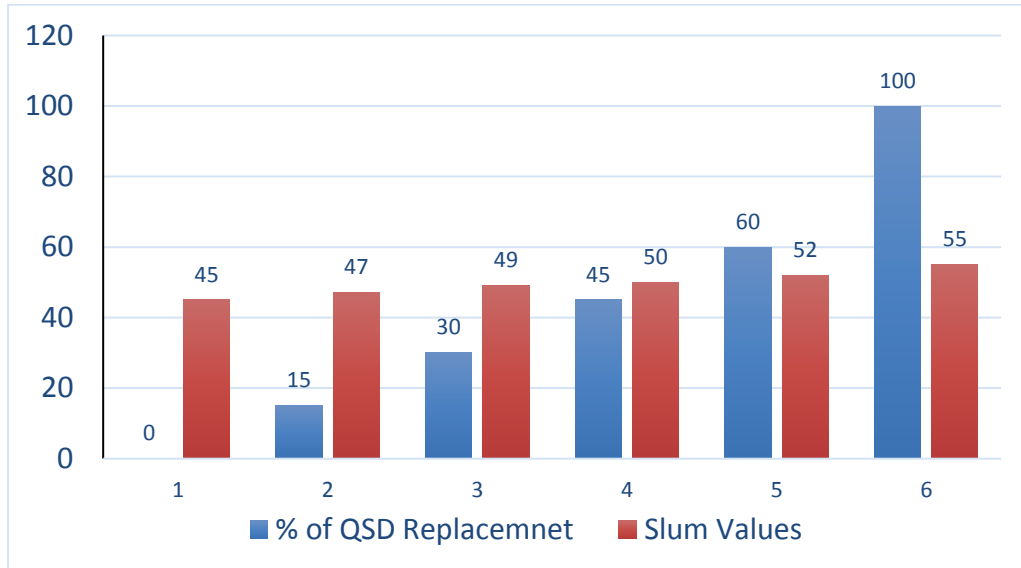


Figure 4: Slum Values for various percentage replacement of QSD

From Figure 4, no significant change of the slum values with increasing QSD replacement.

Compressive Strength

Tables 2 show the results of the average compressive strength of each percentage replacement (0% - 100%) with curing age of 3, 7, 14 and 28days respectively.

Table 2: Compressive strength for various % replacement of QSD at different curing age

	0 % QSD	15 % QSD	30 % QSD	45 % QSD	60 % QSD	100 QSD	%
3 Days	10.6	11.6	12.5	12.2	13.1	13.6	
7 Days	14.7	13.1	14.8	15.3	15.5	15.8	
14 Days	19.8	16.8	16.6	20.3	18.5	23.1	
28 Days	22.0	22.1	24.1	24.8	26.1	28.5	

Figure 5 summarizes the compressive strength of concrete with partial to full replacement of fine aggregate with QSD.

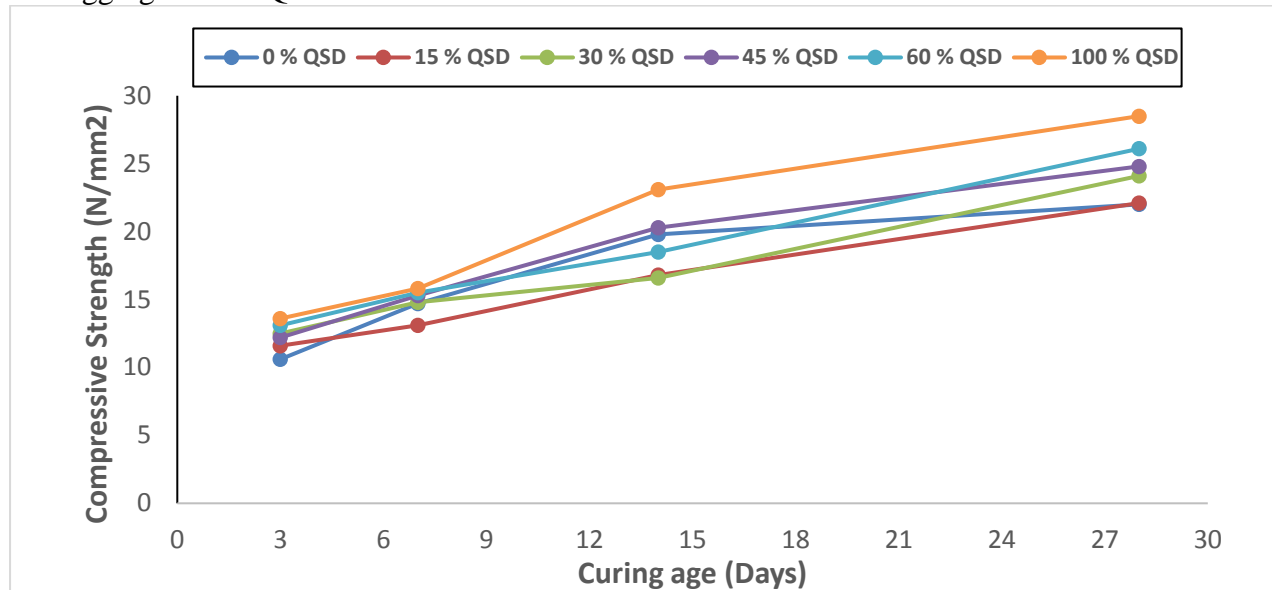


Figure 5: Variation of compressive strength with QSD and curing age (days)

It can be observed that the compressive strength increases with both increasing in curing age and percentage replacement of QSD, this is indicating strong positive correlation between these two factors. However, with minimum percentage replacement of QSD of 45% the researcher was able to achieve 24.8 N/mm² strength which is very close to the target strength of 25 N/mm². The highest compressive strength of 28.5 N/mm² was obtained at 100% QSD followed by 26.1N/mm² at 0% QSD (control). Also, it can be seen that at early age of concrete, there is no significant difference between the strength at various replacement but at later age, the difference seems to manifest between various % replacements.

CONCLUSION

From the results obtained it can be concluded that; the compressive strength increases with both increasing in curing age and percentage replacement of QSD, this is indicating strong positive correlation between these two factors. However, with minimum percentage replacement of QSD of 45% the researcher was able to achieve 24.8 N/mm² strength which is very close to the target strength of 25 N/mm². Therefore, 45% is the optimum percentage replacement of fine aggregate with quarry stone dust (QSD)

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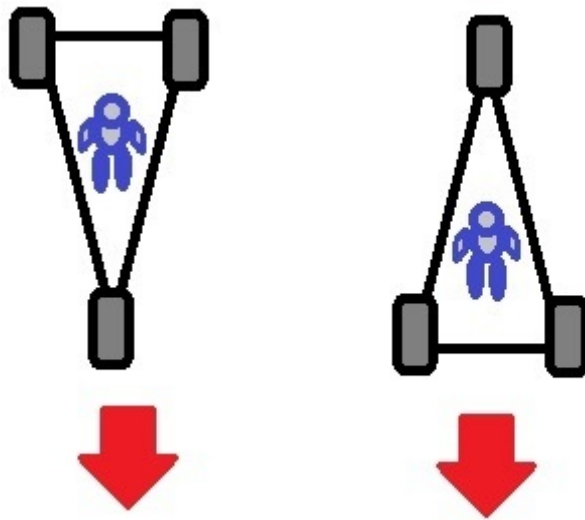
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**CHARACTERISTICS OF A DELTA TYPE THREE WHEELED VEHICLE: A TOOL
FOR ENHANCING THE VEHICLE OPERATIONAL SAFETY*****¹Sunday Bako, ¹Muhammad Sani Abdulkadir, ¹Paul Oscar Yahaya, ²Seun Jesuloluwa**¹Department of Mechanical Engineering, Nuhu Bamalli Polytechnic Zaria, Nigeria²Department of Mechanical Engineering, Nile University Abuja, Abuja Nigeria*E-mail: s2bako@yahoo.com, Phonr Number: +2348034503512**ABSTRACT**

A Three Wheeled Vehicle is an automobile with three wheels; having one or two wheels at the front for steering while the other one(s) for power transmission. Having one wheel at the front and two at the rear the vehicles is known as the delta configuration (type). The second type of three wheeled vehicles is called the tadpole, which is the opposite of the delta type. The presence of three wheels indicates that the vehicles would have different characteristics compared to those of other vehicles. Therefore, there is need to know more about the characteristics of this vehicle in order to ensure good road and passengers' safety. This paper uses simple approach and literatures to highlight the characteristics of this vehicle. This paper aimed at highlighting some characteristics of a Delta type three wheeled vehicles in order to ensure road and passengers safety. It was noted that, the vehicle's Static Stability Factor is inversely proportional to its height of Centre of Gravity. It is hereby recommended that the stability can be improve by placing the centre of gravity much closer to the ground, and by placing the centre of gravity closer to the two (2) rear wheels.

Keywords: Delta and Tadpole, Engine and Dynamic Characteristics.**1. INTRODUCTION**

A Three Wheeled Vehicle is an automobile with three wheels; having one or two wheels at the front for steering while the other one(s) for power transmission. These vehicles are commonly known as: Tuk-tuk in Kenya, Bajaj in Somalia, Tok-tok in Egypt, Rasha in Sudan, Baby Taxi in Bangladesh and Keke-napep in Nigeria. Having one wheel at the front and two at the rear the vehicles is known as the delta configuration (type). The second type of three wheeled vehicles is called the tadpole, which is the opposite of the delta type (Patodi, et al 2014). Delta type of the three wheeled vehicle (Figure 1(a)) has a simple suspension system with fixed camber and caster, while tadpole configurations (Figure 1(b)) has costly suspension systems with variable camber/caster (Zandieh, 2015).



(a)

(b)

Figure 1. Three Wheeled Vehicle Configuration (a) Delta Type (b) Tadpole Type

Delta types are sold with minimal protection against accidents (Rodríguez-Licea, 2021). They are used in Nigeria for commercial transportation. It is the common public transport vehicles in India; with a maximum speed of 65Km/h. The total weight of the vehicle is about 650Kg including the driver and three passengers (Bajaj 2014). While the instability of this vehicle led to limitation of speed and usage of this vehicle (Asuelinmen, Ojolo., and Ajayi. (2020).

In order to combat insecurity and to reduce the rate of accidents caused by motorcyclist in Nigeria; many states government have replaced the use of two wheel vehicles as the means of commercial transportation with the use of Delta type of three wheeled vehicles shown Figure 2. This subsequently raises the numbers of the vehicle users as the means of earning living. The characteristics of these vehicles are not as those of the usual vehicles. Therefore, the need to know more about the characteristics of these vehicles is highly needed by vehicle

users. This leads to the formation of this paper, which is to enlighten the public on the performance of these vehicles in order to ensure, good road and passengers' safety.



Figure 1: Delta Types of Three Wheeled Vehicle Commonly use in Nigeria

2. MATERIALS AND METHOD

The materials used in this paper are: three wheeled vehicle specifications manual, literatures, and AutoCAD (2018) drawing software. Data and information were obtained from literatures and the vehicle manual. The data were also used to describe the characteristics of the vehicle. The AutoCAD (2018) software was used for drawing purpose to illustrate the characteristics of the three wheeled vehicle

3. THE ENGINE CHARACTERISTICS

Delta type of a three wheeled vehicles have rear-engine, rear-wheel drive vehicles, with a single cylinder, two valves, with aluminum engine block (Bajaj 2014). Most engines of these vehicles are four strokes engines and uses petrol as fuel. This means that most of the engine operates in four stroke cycle (induction, compression, power and exhaust stroke) with two valves (one inlet and one exhaust valve), unlike the two stroke engine used by commercial two wheeled motor cyclist. Due to positive scavenging (removing of exhaust gases) and the presence of separate exhaust stroke, the major portion of the exhaust gases are removed from the cylinder of the engines. This results in higher thermal efficiency of the engine (Narang 2004).

The three wheeled vehicle engines are air cooled with an aluminum engine block and a configured fins (Bajaj 2014). Aluminum engine blocks are lighter in weight and better heat dissipation, than the equivalent cast iron block Giri (2010). The engine also runs cooler than the equivalent two stroke engine used by two wheeled motorcyclist. This is because the engines have more time (four strokes) for removing the heat from the engine due to the presence of one working stroke in every four stroke of the piston. Narang (2004) noted that air-cooled engine have difficulty of keeping the engine components at a uniform temperature, and that distortion, noisy running, and ultimate loss of power are caused by temperature variation between the top and bottom of the engine cylinder as well as between the inlet and the exhaust valves. It was also noted by Dolan (1978) that due to the screening of the engine by the vehicle body, efficient cooling is much more difficult to obtain in a rear engine, rear wheeled drive vehicles. Therefore it is advisable that the three wheeled vehicle riders should always monitor the temperature of the engine and change the engine oil as recommended by the vehicle manufacturers in order to ensure good engine lubrication. This would help to prevent the distortion, noisy running, lost due to friction, and the ultimate loss of power.

4. DYNAMICS CHARACTERISTICS

4.1 Steering and Tyre Rotation

It was noted by Raipput (1991) and Abbott (1984) that the weight of all parts of a body are directed toward the centre of the earth and the point through which all the weights act is called the Centre of Gravity (CG). While Mukherejee (2007) noted that, the relatively higher position of center of gravity and the lack of differential for the driving rear axle has been the contributing factor for rollover in three wheeled vehicles. The three wheeled vehicles are rear-engine, rear-wheeled drive. According to Dolan (1978), a rear-engine, rear-wheeled drive vehicles have tendency to over steer; that is the wheels turned too sharply into the curve and needs to be corrected by turning the steering in opposite direction.

Therefore, the three wheeled vehicles are reliable to over steer as a result of increase in rear wheels slip angle. This angle (The angle between the wheel inclination and the path taken by the vehicle) greatly affects the steering characteristic of these vehicles. When the slip angle (θ as shown in Figure 3 ((a)) is greater at the rear than at the front, the vehicle tends to turn into a curve more than how the rider intended. Giri (2010) mentioned that it is generally

accepted that an over steer condition is dangerous and undesirable. If the turning radius is reduced, the magnitude of the centrifugal force (CF) acting through the vehicle centre of gravity (CG) becomes larger so that the over steer tendency of the vehicle is raised; the over steer response further at higher vehicle speed on a given circular path. Since oversteer is unstable and dangerous, therefore the riders should always;

1. Make a turn at a lower speed as possible.
2. Should avoid exceeding the maximum loading capacity of the vehicle.
3. Maintain the recommended tyre pressure.
4. Use larger turning radius as possible.

The instability of the three wheel vehicle can be eliminated by introducing tyres with wider width at the rear wheel of the vehicle (Asuelinmen, Ojolo., and Ajayi. (2020), because the three wheeled vehicle are rear-engine, rear-wheeled drive with rear passengers' position; the rear tyres are reliable to wear at a faster rate than the front tyre. Narang (2004) stated that, to equalized and distribute the tyre wear as well as to obtain maximum tyre life; the tyre should be rotated from one wheel to another after 4800 kilometer. The tyres can be rotated as shown in Figure 3 (b). Tyre rotation is advisable even before the recommended interval if irregular tread wear are observed.

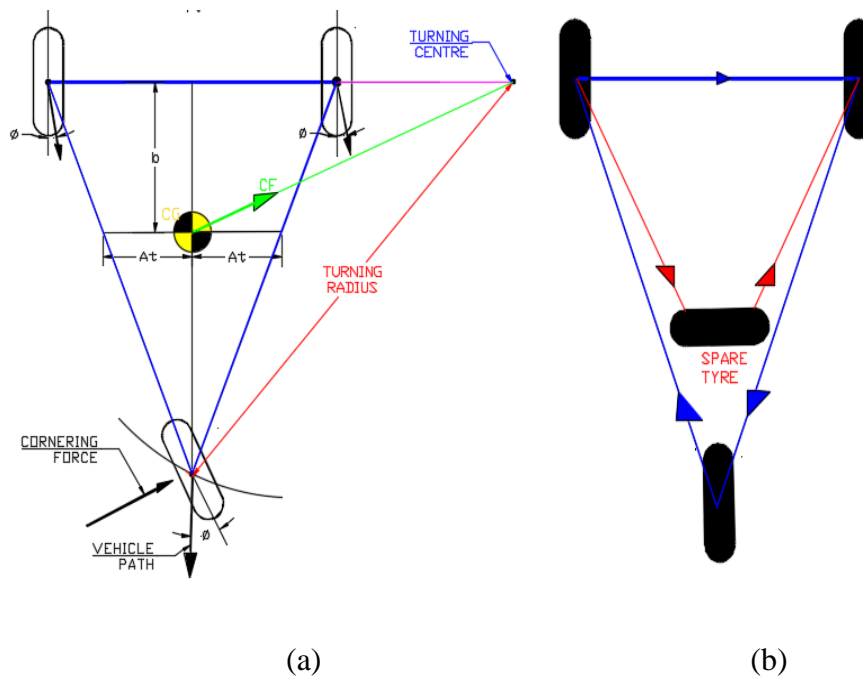


Figure 3 (a) Steering (developed from Dolan (1978)). (b) Tyre rotation (Adapted from Narang (2004))

4.2 Riding Uphill/Downhill and on a Banked Track

The weight of a vehicle moving parallel on a gradient or slope is known as grade resistance. It depends on the steepness of the grade. When riding uphill, some weight would shift to the rear and the grade resistance will act in opposite direction of the vehicle's motion (Figure 4), causing the front of the vehicle to become lighter. This shift in weight also shifts the position of centre of gravity, thereby reducing the tractive effort at the front wheel. When riding downhill, the grade resistance acts in the same direction with the vehicle's motion and gravity increases the amount of braking force required to slow or stop the vehicle. It is therefore important, to begin slowing earlier for stopping. Therefore it is advisable that the riders should not exceed the permissible loading capacity of the vehicles. If this happens, it would increase the grade resistance and cause the vehicle to topple or rollover down the slope (Abdelfatah *et al* 2008, Abdelfatah *et al* 2011, Boumediene *et al.* 2020). Giri (2010).

It was mentioned by Narang (2004) that, when the vehicle is moving on a banked road, it alters its weight (W , $W\cos$, $W\sin$,) distribution on the road (Figure 4 (b)); further movement along the banked road with an increase in banked angle will also reduce the tractive effort at R_f and R_{r1} with a subsequent increase in reaction of R_{r2} . These weights (W and $W\sin$) are transferred toward the banked angle. Giri (2010), also states that if the vehicle continues moving along the banked with an increase in banked angle, a situation would arise when the vehicle would be about to slide down the banked track. It is therefore advisable that the riders should ride at a lower speed as possible and should not exceed the maximum loading capacity of the vehicle.

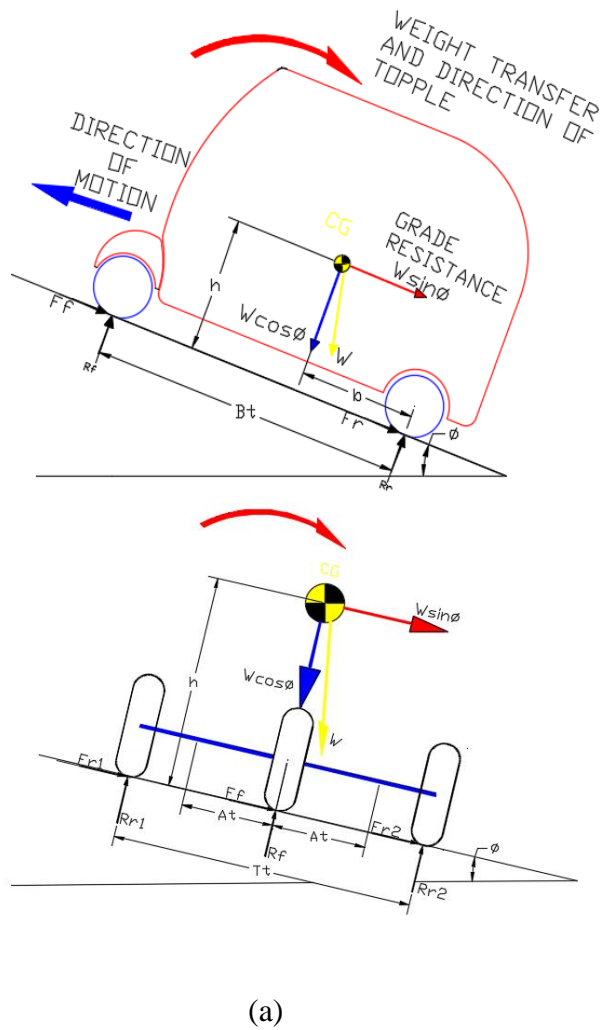


Figure 4. (a) Riding Up- Hill (developed from Giri (2010)). (b) Riding on a Banked Track
(Developed from Giri (2010))

4.3 Braking

A vehicle weight and its kinetic energy act through its center of gravity which is above the ground level. This will cause the vehicle to pitch forward as the brakes are applied. As a result of this action, some of the vehicle weights are effectively transferred from the rear wheel to the front wheels Giri (2010). Consider the vehicle moving on a horizontal road (Figure 5). The weight of the vehicle acts at the centre of gravity (CG) and is distributed at the front and rear wheel of the vehicle. Narang (2004), states that the ratio of these two weights (W_f , & W_r) is called the static weight distribution. It depends upon the horizontal positioning of the centre of gravity ((a) and (b) in Figure 5). Due to the rear-engine, rear-wheeled design of this vehicle, and the rear position of passengers; the weight at the rear is

more than that of the front. This weight would be transfer to the front during braking. This would shift the position of centre of gravity which will affect the stability of the vehicle. Therefore in order to control the amount of weight transfer during braking. The riders should; avoid exceeding the maximum loading capacity of the vehicles.

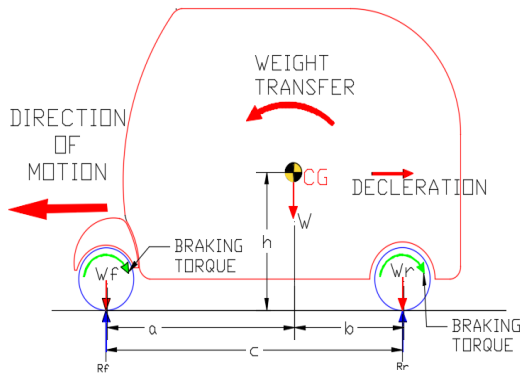


Figure 5. Weight Transfer (Developed from Giri (2010)).

5. LOADING CHARACTERISTICS

The rollover characteristics of a Delta type three wheeled vehicle can be illustrated by stability circle (Jignesh et al., 2017). In the case of three wheeled vehicles,, their body structures are triangular in design. The slant sides from the front wheel to that of the rear wheel are called the rollover lines (Figure 6). It can seen that the radius of the stability circle for the three wheeled vehicle is smaller than of the four wheeled vehicles, even as the wheel base length and the track of the three wheeled vehicle is the same as that of the four wheeled vehicle. Kenneth et al., (1996) noted that the Centre of Gravity (CG) of a loaded vehicle would shift rearward from point “A” to “B” as shown in Figure 6. As the Center of Gravity (CG) of the vehicles shift from ‘A’ to ‘B’ the radius of the stability circle for the four wheeled vehicle remains constant. While that of the three wheeled vehicles increases as shown in Figure 5, which reduces the safety margin against rollover of the three wheeled vehicles compared to the four wheeled vehicles thereby affecting the stability of the three wheeled vehicle. While, Starr (2006) noted that, the crucial vehicle property is the location of its center of gravity (CG). If it is properly located, the vehicle will be stable.

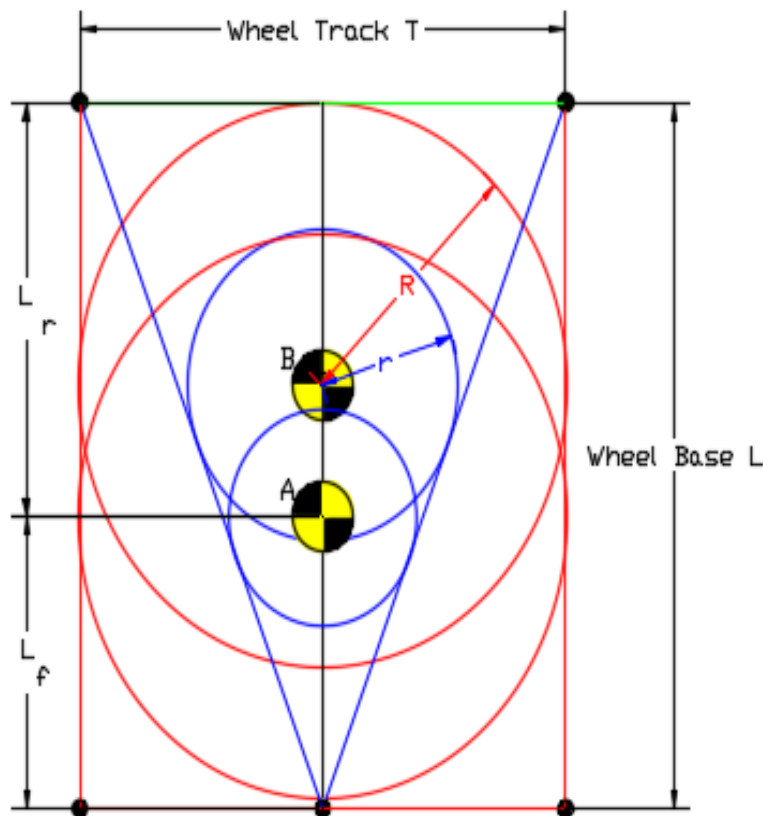


Figure 6. Stability Circle for Three Wheeled and Four Wheeled Vehicle\

Static Stability Factor (SSF) is widely used indicators for indicating the tendency of vehicle rollover intensity (Walz, (2005)). Information from the technical specifications of Bajaj (2014) three wheeled vehicle shows that the vehicle has a wheel base (L) of 2m and wheel track (T) of 1,3m. While, Mukherejee (2007) noted that. the Centre of Gravity location, mass and moment of inertia changes with the inclusion of more passengers (Table 1). To determine the SSF, a modified SSF formula by Jignesh (2017) (equation 1 and 2) was used, with the help of information from Mukherejee (2007).

$$SSF_{2W} = \frac{T}{2h} \times \frac{L - L_f}{L} \times \cos\alpha \quad 1$$

$$SSF_{2W} = \frac{T}{2h} \times \frac{L_r}{L} \times \cos\alpha \quad 2$$

While from Figure 6, α can be determined from

α

$$= \tan^{-1} \frac{T}{2L}$$

3

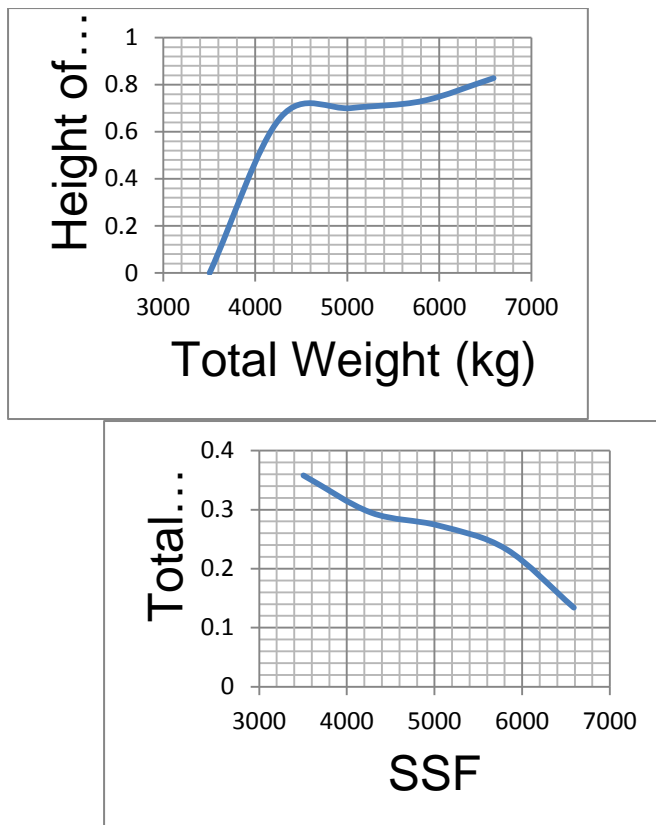
Table 1: Calculated Vale of SSF (Developed from Mukherejee 2007)

Total No. of Occupant (= Driver + n)	Total W (kg)	From Front Axle (L_f) (m)	From Rear Axle (L_r) (m)	Height h (m)	Static Stability Factor (SSF)
1(= 1 + 0)	3505	1.303	0.697	0,602	0.358
2(= 1 + 1)	4276	1.369	0.631	0.661	0.295
3(= 1 + 2)	5047	1.416	0.584	0.701	0.273
4(= 1 + 3)	5818	1.450	0.550	0.731	0.233
5(= 1 + 4)	6589	1.642	0.358	0.828	0.134

n = Number of passengers

The three wheeled vehicles use in Nigeria is designed to carry only three passengers at the rear seat, but the riders tends to carry additional passenger at the front in order to maximized profit. This reduces the driver's control and operating space thereby increasing the chance to road accidents. The fourth passenger was added in Table 1, to show the effects of increase in weight on the vehicle.

The Static Stability Factor (SSF) is an important parameter for measuring the level of rollover resistance of a vehicle. Figure 7 shows that the values of CG height and the SSF are inversely proportional. It was noted that the Static Stability Factor of the three wheeled vehicle decreases as the weight (number of passengers) increases. This increases the rollover intensity of the vehicle, thereby leading to accident.



(a)

(b)

Figure 7. (a) Effect of Weight on CG (b) Effect of Weight on SSF

5. CONCLUSION

This paper presents the characteristics of Delta type of three wheeled vehicle use in Nigeria for commercial transportation.. Having one wheel at the front and two at the rear reduces the cost and design of steering mechanism, but greatly decreases the stability of the vehicles. The rear position of passengers and the rear-engine, rear-wheel drive of the vehicles are the major causes of rollover and overseeing of the Delta type of the three wheeled vehicles. The paper shows that the farther the position of centre of gravity (CG) from the two symmetric wheels

towards the single wheel, the smaller the stability circle for the three wheeled vehicle, which reduces the safety margin against rollover of the vehicles compared to the four wheeled vehicles.

The fight against road accidents does not rest only on the vehicle manufacturers, but also on the public. Therefore education and public awareness are the key factors for reducing the number of road crashes and would prolong the service life of the vehicle. The training and enlighten of the riders and the public would also educate the riders on the characteristics of these vehicles These would help to monitor the static and dynamic characteristics of these vehicles thereby ensuring good road and passengers' safety. It is hereby recommended that the stability can improve by

1. Placing the Centre of Gravity much closer to the ground.
2. By incorporating a differential gear at the rear axle of the vehicle.
3. Significantly increasing the rear tyre width.

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ASSESSMENT OF SUSTAINABLE COMMUNITY MANAGED BOREHOLE SCHEMES AT APADAO AND MARAFA/PEPELE COMMUNITIES, ILORIN EAST LGA, KWARA STATE.

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ABSTRACT

The economic transformation of rural communities relies on sustainable water services delivery. This supports the well-being of inhabitants and enhances wealth creation through agricultural activities. However, there is a trend of failure, abandonment and declining performance of borehole schemes once handed over to rural communities. This poses a significant challenge to rural development and direct impacts on Sustainable Development Goal number six which is universal and equitable access to safe and portable water. To address this issue, a study was conducted to assess the sustainability of community-managed borehole schemes at Apado and Marafa/Pepele communities Ilorin East Local Government Area of Kwara State. The research adopted descriptive statistical tools and multi-criteria analysis approach. The data was collected through questionnaires and field observations. The findings highlighted factors contributing to the non-sustainability of boreholes such as irregular electricity supply, expensive fuel costs, unavailability of spare parts, lack of transparency and accountability within maintenance committees, unwillingness to pay, low water yield during dry seasons and lack of routine maintenance were identified. The study revealed that 18 out of 19 borehole schemes investigated, accounting for 94.7%, were non-sustainable due to ineffective management strategies, while only one scheme equivalent of 5.3% was partially sustainable.

KEY WORDS: Sustainability: Borehole scheme: Functional: Rural community members: Sustainability score

1.0 Introduction

Harvey *et al*, (2003) A sustainable rural water supply encompasses sources that are naturally replenished without being overexploited, ensuring consistently maintained facilities for reliable and ample water provision. It also involves ensuring continual benefits for users over an extended period and employing cost-effective resource utilization methods that can be replicated. In developing nations, there has been recognition of the hand pump as a fitting water supply technology due to its low cost, ease of operation and maintenance, and the availability of shallow groundwater in much of Africa. However, achieving sustainable access to safe drinking water remains a challenge, especially in rural Africa, where low coverage rates hinder progress. Studies by Habtamu (2012), Uzma *et al*. (2020), and Elkanah (2020) emphasize the importance of water supply system functionality over time for

sustainability. They highlight that poor management by communities, lack of participation, water quality issues, disputes, financial constraints, inadequate support, and service breakdowns contribute to the failure of many water supply schemes in developing countries. Additionally, factors such as insufficient project maintenance, absence of water pricing, and lack of payment receipts further impact the sustainability of water projects. In Kenya, the adoption of community ownership and management strategies involves water and sanitation committees handling day-to-day maintenance. However, some failures in these schemes are attributed to low sustainability rates due to a lack of ownership, inadequate education on water supply and sanitation, and poor management skills. Proper sustainability strategies are crucial for rural water supply projects to meet their intended beneficiaries' needs over time. Specifically in Nigeria, David et al. (2020) noted that many rural water facilities have collapsed, leaving rural dwellers facing challenges in accessing water, relying on streams and rivers. Kilimo et al. (2018) highlighted that merely constructing water projects doesn't ensure sustainable clean water provision, as many projects deteriorate shortly after being handed over to communities. The study's problem revolves around the rapid abandonment, failure, and decline in performance of borehole water schemes after handover to rural communities, posing a significant challenge to rural development. This is attributed to the communities' inadequate grasp of sustainability strategies and behavioral attitudes, leading to persistent water poverty, reliance on polluted sources, and wastage of resources invested in water schemes. The research aimed to evaluate the sustainability of community-managed borehole schemes in Ilorin East LGA, Kwara State. Its specific objectives were to identify the factors influencing sustainability, rank these factors and sub-factors according to their significance, assess sustainability levels on the field for each sub-factor, calculate weighted aggregates for each sub-factor, determine total sustainability scores for the schemes, and categorize their sustainability levels and statuses in the study area.

2.0 Literature Review

RWSN (2009) estimated that one in three hand pumps in Africa are not working at any given time. Rosenberg (2011) It has been noticed that the expense associated with repairing broken hand pumps and faulty piped networks across sub-Saharan Africa far exceeds the cost of regular preventative maintenance. Numerous water points are left unused before their time due to financial obstacles or challenges in acquiring the required parts and technical support. Sizwe et al. (2012) It has been pointed out that there has been a greater emphasis on

designing and constructing water systems rather than ensuring their long-term sustainability and development. In rural communities in sub-Saharan Africa, approximately 30% of water supply systems are non-functional, having broken down and subsequently been abandoned. Many African countries exhibit operational failure rates ranging from 30% to 60%. The insufficient sustainability levels are attributed to various community-related factors such as limited demand, affordability or acceptability issues, and inadequate ownership and participation within certain regions of Africa

According to Okorie *et al* (2001) In a research conducted in Swaziland, a significant factor contributing to the lack of sustainability in numerous rural water supply projects is linked to the imposition of unsuitable technologies, the absence of spare parts, insufficient local maintenance and operational capabilities, inadequate community education and involvement, ineffective community demand, and a lack of coordination among sector agencies. The community's readiness to invest their time and resources into these projects is pivotal for their long-term viability.

Elkanah, (2020) Research discovered that the primary reason behind the inadequate sustainability of 38 community-managed rural water supplies in Dodoma villages, Tanzania, stemmed from weak revenue collection, lack of accountability among water committees, inadequate financial management, and the failure to achieve cost recovery. It is imperative for community members to be equipped with the requisite knowledge regarding the operation, repair, and maintenance of water supply systems to bolster project sustainability. Financial considerations crucial for the sustainability of a water supply system include effective revenue collection, capability to cover operational and maintenance costs, and willingness to pay for services. Sustainable water supply projects rely on tariffs generating adequate resources for system operation and infrastructure replacement at the end of its service life. Financial resources are essential for Operation and Maintenance (O&M) to uphold system functionality; the inability of communities to collect sufficient revenue for repairs may diminish the longevity of installed water supplies. Inadequate financing stands out as a significant factor contributing to poor maintenance, frequently cited as the primary cause of project failure.

Oloruntade *et al*. (2015) It was noted that Nigeria continues to face significant water scarcity issues for domestic, agricultural, and industrial uses, primarily due to the alarming rate of borehole failures resulting from technical, political, and financial challenges. Despite

substantial investments in water supply infrastructure in Nigeria, as of 2009, the country ranked 130th out of 147 nations on the World Water Poverty Index and held the third position globally in terms of inadequate water supply and sanitation coverage..Ademiluyi, *et al* (2008) It was confirmed that insufficient community training could result in the breakdown and unsustainability of water supply initiatives in developing nations. Oloruntade et al. (2015) conducted a study on borehole failure rates in the Akoko Area of Ondo State, Nigeria. The findings revealed that fewer than 50% of installed water points, including hand pumps and motorized systems, were operational. Specifically, 57% of the hand-pump-equipped boreholes and 47% of the motorized ones had experienced failure.

Godfrey et al (2009) found that the provision of water supplies without operation and maintenance results in low levels of sustainability and to achieve a sustainable water supply, there is a need for active community involvement, improved training and strong water point committees. Eduvie (2004) It was suggested that in order for Nigeria to achieve the Millennium Development Goals (MDGs) target for water supply specifically in rural areas, each borehole would need to cater to a population of 230-500 individuals residing within a 500-meter radius of the water source. Considering that 50% of the population resides in rural regions, which are designated to be served by hand pump boreholes, the country might necessitate approximately 2,000 boreholes for every 1 million people. Consequently, to provide safe drinking water for the 70 million rural inhabitants, an estimated 140,000 boreholes would be required, assuming no population growth.Laah, *et al* (2014) noted that lack of community training could lead to breakdown and non-sustainability of water supply projects in developing countries. Kilimo et al. (2018) established that use of hand-pump fitted boreholes would enhance potable water supply in the area owing to its low operational efficiency, effectiveness, affordability and availability of spare parts.

Oloruntade*etal.*.(2015) The study revealed that many community-led water supply initiatives have failed due to deficient community management, insufficient community involvement, absence of institutional support in administration and technical training, financial limitations, water quality issues, failure to collect funds, and insufficient operation and maintenance efforts.. Uzma et al. (2020) estimated that, on average, 36% of hand pumps across sub-Saharan Africa are non-functional at any given time, with some countries experiencing rates exceeding 60%. Sara (2012) noted that water supply projects managed and maintained by the

community demonstrate greater sustainability compared to those managed by local governments

Augustine *et al.*, (2020) Various factors contribute to the limited water supply in rural communities in Nigeria. These encompass rapid population growth, the seasonal nature of water sources, lack of water infrastructure, distant proximity to stream or spring water sources, lack of protection for such sources, insufficient community involvement, absence of political determination, politicization of water projects, financial constraints, aging water infrastructure, misuse of funds allocated for water supply projects, topographic limitations, inadequate maintenance of water supply facilities, traditional and cultural influences, urbanization, vandalism and destruction of water facilities, geological factors, and issues related to ownership of water supply facilities.

Oloruntade *et al.*, (2015) enumerated the causes of borehole failure in Nigeria to include lack of expertise or inexperience and poor performance of the driller, poor supervision, peculiar characteristics of the aquifer, poor technological and poor handling by well users.

Kerstin *et al.*, (2012) It was elucidated that the development of rural water supply for domestic purposes has primarily emphasized infrastructure construction rather than ensuring the provision of a lasting service. If the expenses related to operation and maintenance cannot be covered, the water system will inevitably deteriorate.

DWAF (2004) It was observed that the sustainability of a rural water supply and sanitation scheme hinges on the collection of funds to cover operation and maintenance (O&M) expenses, major repairs, and management/administration costs. Various costs are involved in accessing, pumping, treating, storing, piping, metering, controlling, maintaining, and protecting the water resource. Implementing transparent accounting practices and enhancing community acceptance through effective fund collection can boost public motivation and overall revenue collection. Additionally, grooming today's youth for future roles in contributing to, managing, and leading water supply and sanitation schemes is essential for their long-term sustainability..

3.0 Materials and Method

3.1 Determination of Criteria

This process includes pinpointing and choosing all pertinent variables crucial for assessing the sustainability of a water scheme. These variables encompass financial, institutional,

technical, and environmental/social aspects. They were then categorized into twenty-eight (28) sub-factors, serving as indicators for sustainability.

3.2 Data Collection

To meet the study's objectives, various research tools and methodologies, encompassing both primary and secondary data collection techniques, were utilized. These methods included distributing structured questionnaires among community members, conducting informal interviews, and performing field observations. Systematic random sampling was employed while administering the questionnaire to ensure capturing direct and pertinent information from respondents, allowing them to freely express their perspectives. The questionnaires were structured into five distinct sections. Section one focused on gathering background information such as education, income levels, and available water sources. Section two delved into technical aspects, covering construction quality, scheme complexity, training, spare part availability, operation and maintenance protocols, water quality control measures, and disaster contingency plans. Section three addressed social and environmental factors, encompassing the existence of water committees, social inclusion of various demographics, community relationships, seasonal variations, and water quality and quantity. Section four centered on financial aspects, probing into willingness to cover operational and maintenance costs, utilization of surplus funds, sources of project financing. Lastly, section five elucidated community participation and commitment, external support, policies and regulations, ownership of the scheme, and community activities. etc.

3.3 Method of Data Analysis

The Multi-criteria analysis method was adopted from (Panthiet *al.*2008) and (Petrosetal .,2013) in assessing the sustainability of community managed borehole schemes in selected villages in Ilorin East area of Kwara State. The method covers:

(i) **Weight Allocation** Assigning weights or importance values to selected criteria aims to represent their relative significance concerning the overall effectiveness of sustainability. This process often involves professional judgment and consultation with stakeholders. The objective behind allocating weights is to emphasize factors that hold greater significance in the evaluation of a water scheme's sustainability. In Table 1, for this study, 40% weight was allocated to the financial variable, signifying its primary role. Technical aspects were allotted

30%, while social/environmental and institutional factors were assigned 15% each, reflecting their relative influence in this evaluation.

(ii) **System Appraisal:** At the project site each sub- factor were again scored, marked or judged on a six point scale for each water individual scheme: excellent (80-100%); very good (70-79%); good (50-69%); fair (30 - 49%) poor (< 30%) and zero for non existence. The scores reveal the performance or overall conditions of the scheme with regards to the specific criterion

(iii) **Weighted Aggregation:** The scores of each criterion are multiplied by their corresponding weight to reflect their significance, resulting in aggregated scores for each scheme. Summing up the scores of all variables within each water project provides the sustainability score for that specific project. This aggregated score serves as a comprehensive representation of the overall sustainability performance of the scheme.

(iv) **Sustainability Categorization:** The weighted aggregate or sustainability score determines the classification of a water scheme as sustainable, partially sustainable, or unsustainable. If the sustainability score falls below 30%, it is classified as unsustainable. A score ranging between 30% and 70% is deemed partially sustainable, while a score above 70% to 100% signifies sustainability.

Table 1: Factors, sub-factors and assigned weight use to calculate the sustainability scores

Factors	Sub- Factors	Assigned
		Weight
A.1 Technical (0.3)	A.1.1 Construction quality	0.04
	A1.2. Water quality at source	0.035
	A.1.3. Complexity of the scheme	0.035
	A1.4 Routine maintenance	0.05
	A1.5 Condition and functionality of system	0.02
	A1.6 Contingency for natural disasters	0.02

	A1.7 Availability of spare parts/Equipments	0.015
	A1.8 Water quality control mechanism	0.015
	A1.9 Training and technical skills	0.04
	A1.10 Water fetching time	0.01
	A1.11 Status of meeting additional demand	0.02
	A2.1.. Harmonious relationship / conflict resolution	0.03
A2. Social / Environmental (0.15)	A2.2. Equity& Inclusion (ethnic group)	0.02
	A2.3. Vulnerability& adequate protection	0.03
	A2.4. Seasonality, quality& quantity	0.03
	A2.5 Availability of alternative water source	0.04
	A3.1. Establishment of O and M fund	0.08
	A3..2 Regular tariff payment / Willingness to pay	0.1
A3. Financial (0.4)	3.3 Organized accounting	0.05
	3.4. Cost recovery system	0.1
	3.5 Use of savings / surplus	0.07
	A4.1. Existence, functioning and meetings Userscommittee	0.01
	A4.2 Ownership of scheme and activities	0.01
A4. Institutional (0.15)	A4.3 Policies and regulatory mechanism	0.03
	A4.4 Existence of maintenance committee	0.02
	A4.5 Functioning	0.04
	A4.6 Transparency& responsibility	0.01
	A4.7 External support	0.03

4.0 Result and Discussion

4.1 Sustainability scores of each water scheme at Apado community

The sustainability evaluations of each water scheme in the Apado community indicated that 25% of the schemes were operational but unsustainable, 67% were non-operational and unsustainable, while 8% were partially sustainable and functioning, notably constructed in 2022. The sustainability scores ranged from 11.95 to 29.525 for each scheme, indicating that only 8% partially met sustainability criteria, with 92% falling short despite some being operational. This deficiency has been attributed to plumbing issues and other unsustainable practices that prematurely diminish the lifespan and functionality of the schemes, such as well dryness, pipe bursts, turbid water, corrosion of metallic components, pipe leaks, leaking storage tanks, tanks being blown off by wind, and the presence of dead animals like birds and lizards in unsealed steel tanks..

Additional findings include inadequate accountability and transparency of water fund management leading to suspicion and discouragement, the presence of alternative water sources, reliance on the government to carry out maintenance due to perceived government ownership, migration of trained and skilled individuals to urban areas in search of employment, reliance on technicians from Ilorin metropolis for repairs, a lack of sense of ownership, irregular tariff payments, absence of daily revenue collection until repair needs arise, unavailability of spare parts, absence of electricity to power motorized boreholes, lack of funds to fuel generators, presence of old and faulty generators, and poor maintenance practices.

4.2 Sustainability scores of each water scheme at Marafa/ Pepele community

The sustainability assessments of each water scheme in the Marafa/Pepele community revealed that 29% of the schemes were operational yet unsustainable, while the remaining 71% were non-functional and unsustainable. The sustainability scores ranged from 12.9% to 27%, indicating that none of the schemes met the necessary conditions for sustainability, despite some being operational. The low sustainability scores point to inadequate sustainable management and the overall sustainability level of the schemes, stemming from various

plumbing issues such as leaky pipes, corroded valves, failed pumps, and damage to solar panels used for power. Other contributing factors include a lack of willingness to pay for water services, limited funds available only for minor maintenance tasks, low water yield from the schemes especially during dry seasons, absence of an effective and coordinated maintenance committee, insufficient skills and technical expertise within the community, absence of alternative means of generating funds for operation, construction, and maintenance, lack of commitment among community members, unavailability of spare parts within the community, reliance on the government to carry out maintenance assuming it as government property, utilization of multiple water sources by most community members, willingness to pay for maintenance only during dry seasons by some members, reluctance to pay due to perceived lack of accountability and transparency within the committee, absence of contingency plans for natural disasters, and inadequate cost recovery mechanisms.

4.3 Summary of sustainability scores for borehole water schemes under study

Table 2 The compiled sustainability scores for the assessed borehole schemes indicate that out of the 19 evaluated, 18 of them, representing 94.7%, were classified as unsustainable. Only one scheme, making up 5.3%, was identified as partially sustainable. Despite a handful of operational schemes, their sustainability remained notably low due to the adoption of unsustainable practices by the beneficiaries of these water supply facilities. The significant proportion of non-sustainable water projects within the community poses a considerable risk to water availability, accessibility to safe drinking water, and the economic advancement of rural areas..

Table 2: Summary of sustainability scores for borehole water schemes under study

Project Number/ Name	Project Scores	Categorization and Status
AMR 1	14.05	Not Sustainable & Non Functional
AMR 2	29.525	Partially Sustainable & Functional
AMR 3	23.325	Not Sustainable & Non Functional
AMR 4	22.65	Not Sustainable & Functional
AMR 5	11.95	Not Sustainable & Non Functional
AHP 1	28.775	Not Sustainable & Functional
AHP 2	17.85	Not Sustainable & Non Functional
AHP 3	28.275	Not Sustainable & Functional
AHP 4	13.75	Not Sustainable & Non Functional
AHP 5	12.95	Not Sustainable & Non Functional

AHP 6	13.75	Not Sustainable & Non Functional
AHP 7	12.7	Not Sustainable & Non Functional
PMR 1	27.2	Not Sustainable & Functional
PMR 2	23.15	Not Sustainable & Functional
PMR 3	12.9	Not Sustainable & Non Functional
PMR 4	14.125	Not Sustainable & Non Functional
PHP 1	16.3	Not Sustainable & Non Functional
PHP 2	15.95	Not Sustainable & Non Functional
PHP 3	16.4	Not Sustainable & Non Functional

5.0 Conclusion

The research investigated the sustainability of community-managed rural water supply schemes in Apado and Marafa/Pepele communities, Ilorin East LGA, Kwara State. Results indicated that most of these schemes had low sustainability scores, suggesting their lack of sustainability. This has led to a significant number of abandoned water schemes in rural areas. Importantly, the study emphasized that while not all operational schemes could be considered sustainable, all sustainable schemes were operational.

6.0 Recommendations

The following were recommended from the study:

- (i) Government and donor agencies should avoid assuming that communities can effectively manage their water schemes independently. Instead, they should provide capacity development training in water project management before handing over the responsibility to the community, enabling them to operate, repair, and maintain the scheme.
- (ii) Ensuring accountability and transparency in the maintenance committee's handling of collected revenue is essential to prevent suspicion and discourage community members.
- (iii) Raising awareness about the importance of willingness to pay can enhance revenue generation, promote cost recovery, and improve service delivery.
- (iv) The community should be allowed to choose the members of committee not by imposition to establish trust.

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APPENDIX



Plate 1: A functioning and partially sustainable motorized borehole at Apadocommunity (AMR2)



Plate 2: A nonfunctioning and unsustainable motorized borehole at Apado community (AMR3)



Plate 3: A functioning and unsustainable motorized borehole at Apadocommunity(AMR4)



Plate 4: A non-functioning and unsustainable motorized borehole at Apado community (AMR5)



Plate 5:A functioning and unsustainable hand pump borehole at Apado community
(AHP1)



Plate 6:A non- functioning and unsustainable hand pump borehole at Apado community
(AHP2)



Plate 7: A functioning and unsustainable hand pump borehole at Apado community (AHP3)



Plate 8 A non- functioning and unsustainable motorized borehole at Apado community (AHP4)



Plate 9: A non-functioning and unsustainable motorized borehole at Apado community (AHP5)



Plate 10: A non-functioning and unsustainable hand pump borehole at Apado community (AHP6)



Plate 11: A non-functioning and unsustainable hand pump borehole at Apado community (AHP7)



Plate 12: A functioning and unsustainable motorized borehole at pepele community (Elesinmeta) (PMR1)



Plate 13: A non-functioning and unsustainable motorized borehole at Pepelecommunity(MarafaOja)(PMR3)



Plate 14: A non-functioning and unsustainable motorized borehole at Pepele community (Elesin Meta) (PMR4)



Plate 15: A non-functioning and unsustainable hand pump borehole at Pepelecommunity (Ayetoro Ile) (PHP1)



Plate 16: A non-functioning and unsustainable hand pump borehole at Pepelecommunity (MarafaOja) (PHP2)



Plate 17: A non-functioning and unsustainable hand pump borehole at Pepelecommunity (MarafaOja) (PHP3)

**INFLATIONARY PRESSURES, EXCHANGE RATE VOLATILITY AND FUEL
PRICE DYNAMICS IN NIGERIA: AN EMPIRICAL ANALYSIS****Adamu, Maryam Bala¹ & Bulus, Bulus Tim.²**^{1,2}Department of Economics, Ahmadu Bello University Distance Learning Centre, Zaria,
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ABSTRACT

This study investigates the dynamic relationships between fuel prices and key economic indicators in Nigeria, employing an Autoregressive Distributed Lag (ARDL) model within the framework of Cost-Push Inflation, the Law of One Price Gap, and the Marshall Lerner Condition/J-Curve. Analyzing data spanning from 1986 to 2023, the study uncovers significant short-run and long-run effects. In the short run, core inflation exhibits a marginally significant negative impact, while food inflation, exchange rate, and GDP per capita exert positive influences on fuel prices, with varying degrees of significance. In the long run, changes in core inflation and food inflation continue to impact fuel prices, emphasizing the persistence of these relationships. Furthermore, the cointegrating equation reveals a corrective mechanism towards a long-term equilibrium, suggesting the presence of factors influencing market stability. The study provides nuanced policy implications, emphasizing the importance of inflation management, exchange rate stability, economic growth strategies, and addressing factors hindering long-run equilibrium. These findings offer valuable insights for policymakers in crafting effective strategies to navigate the intricate web of economic variables influencing fuel prices in Nigeria, promoting stability and sustainable economic growth.

Key Words: Inflationary Pressures; Exchange Rate Volatility; Fuel Price Dynamics, GDP Per Capita; Nigeria.

1.0 Introduction

The rising costs of food items in Nigeria may be directly influenced by the significant factor of transportation expenses. Fuel prices play a critical role in these expenses, as they fluctuate and impact the amount of money spent on transporting food items. When fuel prices rise, transportation costs increase, resulting in higher prices of food items in the markets. The cost of transportation, influenced by fuel prices, road conditions, and government taxes, directly contributes to the rising costs of food items. The present-day economic realities orchestrated increasing prices of commodities (consumable and durable) across the country is felt by the populace and thus, the price increase has affected individuals in several ways, such as reduction in the standard of living of the people, high interest rate, etc. The factors which affect this price escalation of consumable and durable commodities are broadly categorized into human and natural factors. Firstly, the prices of the consumable and durable commodities will be high because of the activities of middlemen in the process of distribution

of the goods. Also, it has been proved that production cost is a direct variable on the price of goods (Sari & Sari, 2023).

Core inflation and food inflation serve as critical indicators of inflationary pressures within the Nigerian economy. Shifts in these inflation measures reflect changes in the overall price level, impacting production costs, consumer purchasing power, and inflation expectations (Smith, 2020).

Exchange rate volatility plays a significant role in fuel price dynamics by affecting the cost of importing fuel and related goods. Fluctuations in the exchange rate can lead to variations in the prices of imported fuels, directly influencing domestic fuel prices and overall inflation trends (Nasir & Mary, 2019). GDP per capita serves as a gauge of the economic well-being of the population and acts as an indicator of overall economic growth and development. Changes in GDP per capita can influence fuel demand, consumer spending habits, and government policies designed to foster economic stability and prosperity.

The relationships among inflationary pressures, exchange rate volatility, GDP per capita, and fuel price dynamics are intricate and interconnected. Changes in inflation, exchange rates, and GDP per capita can mutually influence each another, impacting fuel prices through diverse channels such as production costs, consumer behavior, import expenses, and government policies.

Through an analysis of these interconnections within the conceptual framework, this study aims to provide insights into the drivers of fuel price dynamics in Nigeria. By doing so, it seeks to inform policy decisions aimed at promoting economic stability, sustainability, and inclusive growth in the country.

2.0 Literature Review

Hypothetically, several theories explain inflation and exchange rate dynamics. Amongst these includes, the Cost-Push Inflation doctrine, the Law of One Price Gap, Marshall Lerner Condition, and the J-Curve theory to comprehensively analyze the dynamics of fuel prices in Nigeria. These frameworks offer insights into how global market forces, exchange rate fluctuations, and trade dynamics contribute to the observed patterns in fuel prices, thereby informing policymakers and industry stakeholders.

Cost-push inflation occurs when production costs rise, leading producers to pass on these increased costs to consumers through higher prices. In the context of Nigeria's fuel price

dynamics, this theory helps explain how changes in core inflation (excluding volatile elements like food and energy) and food inflation influence fuel prices. Nigeria's fuel production involves costs related to extraction, refining, transportation, and distribution, with crude oil prices being a major component. Fluctuations in global oil prices and geopolitical events can lead to cost-push inflation in the fuel sector, impacting domestic fuel prices.

The Law of One Price Gap posits that identical goods should sell for the same price when expressed in a common currency. In other words, if two products are essentially the same and can be freely traded between two markets, their prices should be equal after accounting for exchange rates and other transaction costs (Persson, 1998). This principle is fundamental in international trade and helps ensure that markets are efficient and that arbitrage opportunities are minimized. However, deviations from this law may occur due to factors like transportation costs, taxes, and market structures. In the context of fuel prices, this framework helps understand how external factors influence fuel prices and contribute to overall dynamics. Nigeria, being a significant player in the global oil market, is subject to this law. While oil prices are globally determined, local factors such as transportation costs, taxes, and market structures can lead to deviations from the law, affecting fuel pricing.

The Marshall Lerner Condition examines the relationship between exchange rate changes and the trade balance, suggesting that a currency devaluation will improve the trade balance if the sum of price elasticities of exports and imports is greater than one. Conversely, the Marshall-Lerner Condition is a principle that addresses the responsiveness of a country's trade balance to changes in its exchange rate (Nasir & Mary, 2019). It is based on the idea that if a country's currency depreciates (its exchange rate falls), its exports become cheaper for foreign buyers, and its imports become more expensive for domestic consumers (Feenstra & Romalis, 2014). In the context of fuel prices, exchange rate fluctuations impact the cost of importing petroleum products, thus influencing domestic fuel prices. Nigeria, being a net importer of refined petroleum products, is affected by changes in exchange rates.

The J-Curve theory, on the other hand, suggests that a currency depreciation may initially worsen the trade balance before improving in the long run. However, the J-Curve is a graphical representation of how a country's trade balance reacts to a depreciation or devaluation of its currency over time (Nasir & Mary, 2019). Initially, when a currency depreciates, the trade balance may worsen (the trade deficit may increase) because it takes

time for consumers and businesses to adjust their purchasing behavior in response to the changed relative prices. Over time, as consumers and foreign buyers adapt to the new price levels, the trade balance is expected to improve, eventually resulting in a trade surplus (Feenstra et al., 2014). Nigeria's dependence on oil exports and its role as a net importer of refined petroleum products make it susceptible to the J-Curve phenomenon. Therefore, analyzing these theories helps understand the short-term and long-term effects of exchange rate movements on fuel prices in Nigeria.

Several studies have been conducted to examine/determine the link between fuel prices, inflation and exchange rate dynamics. Diaz-Bonilla et al. (2019) examines the impact of transportation on food prices in Latin America. The researchers explore both the direct and indirect effects of transportation costs, including fuel prices, infrastructure quality, and logistical efficiency.

Economic studies also contribute to the understanding of transportation's effect on food costs. In a study by Balagtas and Martinez (2018), the authors analyze the relationship between transportation infrastructure investments and food prices in the United States. They find that improvements in infrastructure, such as highways and rail systems, can reduce transportation costs and subsequently lower food prices. Transportation industry reports provide valuable insights into the specific challenges and trends affecting transportation costs. A report by the International Road Transport Union (2017) examines the impact of rising fuel prices on the transportation of food and agricultural products. It highlights the need for efficiency improvements in the transport sector to mitigate the impact of fuel price fluctuations on food costs. Kilian (2013) suggests that the price of crude oil, the primary source of fuel, is determined by a complex mechanism that varies according to supply and demand structure for physical oil, as well as paper trading activity, including speculation of forwards, futures, options, and swaps. The price of crude oil is also influenced by geopolitical events, such as wars, sanctions, and political instability in oil-producing countries. Aloui and Aïssa (2016) also suggests that the price of crude oil is positively correlated with the price of other commodities, such as metals and agricultural products, due to the interdependence of global markets. Fluctuations in fuel prices, driven by global oil markets and geopolitical factors, directly impact transportation costs for commodities. High fuel prices lead to increased operational costs for transportation, affecting the overall cost of delivering commodities to markets (Smith, 2020)

Hamilton (2013) reported that inflation can lead to an increase in the price of commodities by reducing the purchasing power of consumers and increasing the cost of production. For example, an increase in the price of oil can lead to an increase in the cost of transportation, which can lead to an increase in the price of goods and services. Goodhue and Rausser (2015) also reported that inflation can lead to changes in the demand for commodities, with consumers switching to cheaper alternatives. Inflation erodes purchasing power, leading to an increase in the cost of producing and transporting commodities. As the general price level rises, so do the prices of commodities, impacting consumers' purchasing decisions (Brown, 2019).

In a study conducted by, Osabuohien, Obiekwe, UrhieandOsabohien (2018) which focused was on Nigeria's inflation and exchange rate volatility. Their findings revealed the differential impact of exchange rates on inflation, indicating that the parallel exchange rate influences short-term inflation, while the official exchange rate affects long-term inflation. Similarly, Aliyu, Tijjani and Elliott,(2015)highlighted asymmetric cointegration between exchange rates and trade balance, suggesting a slower transmission of exchange rate depreciations into Nigeria's trade balance, aligning partially with the Dutch disease hypothesis.

Wesseh and Lin (2018)scrutinized Liberia's economy, unveiling the stimulating effect of rising oil prices on GDP, juxtaposed with the detrimental impact of currency depreciation on GDP. Omotosho (2021) delved into oil price shocks and fuel subsidies in Nigeria, elucidating their substantial impacts on output, inflation, and the exchange rate. Inegbedion, Inegbedion, Obadiaru & Asaleye (2020) demonstrated the repercussions of reducing petroleum subsidies in Nigeria, elucidating how such reductions trigger price increases across sectors, emphasizing the interdependence among these sectors. Zubair, Adams and Aniagolu (2021)evaluated factors influencing Nigeria's inflation rate, highlighting the Consumer Price Index (CPI) as a statistically significant driver of inflation. Adeyemo (2017) employed regression analysis to investigate the relationship between transportation costs and food prices in Nigeria. The data used in the study were obtained from the National Bureau of Statistics and covered the period from 2000 to 2015. The study found that transportation costs have a significant positive effect on food prices in Nigeria.

3.0 Methodology

In this study, we adopted time series analysis as the primary methodology to examine the characteristics of the key variables relevant to our investigation. This methodological choice

was made to gain a comprehensive understanding of the impacts of Core Inflation, Food Inflation, Exchange Rate Volatility, and GDP per Capita on fuel price dynamics in Nigeria. Our aim was to leverage data from secondary sources to acquire reliable information and build extensive datasets related to the variables of interest, thereby facilitating thorough and credible analysis.

Given the specific focus of our study, we collected secondary data spanning from 1986 to 2023. All data utilized in our research were sourced from the World Bank Development Statistics, covering pertinent variables such as core inflation, food inflation, exchange rate volatility, GDP per capita, and fuel prices over a period of 38 years from 1986 to 2023. This comprehensive dataset enabled us to explore the dynamics and interrelationships among these variables, providing valuable insights into the factors driving fuel price movements in Nigeria

The Autoregressive Distributed Lag (ARDL) model equation employed in this study investigates the relationship between fuel prices (FP) and the independent variables: core inflation (COINFL), food inflation (FOINFL), exchange rate (EXCR), and GDP per capita (GDPPC). The model is expressed as follows:

$$\begin{aligned} \Delta FP_t = & \alpha + \beta_1 FP_{t-1} + \beta_2 COINFL_{t-1} + \beta_3 FOINFL_{t-1} + \beta_4 EXCR_{t-1} + \beta_5 GDPPC_{t-1} + \\ & \delta_1 \Delta FP_{t-1} + \delta_2 \Delta COINFL_{t-1} + \delta_3 \Delta FOINFL_{t-1} + \delta_4 \Delta EXCR_{t-1} + \delta_5 \Delta GDPPC_{t-1} + \\ & \sum_{i=1}^p \theta_i \Delta FP_{t-i} + \sum_{i=0}^q \phi_i \Delta COINFL_{t-i} + \sum_{i=0}^r \square_i \Delta FOINFL_{t-i} + \sum_{i=0}^s \square_i \Delta EXCR_{t-i} + \\ & \sum_{i=0}^u \eta_i \Delta GDPPC_{t-i} + \lambda ECT_{t-1} + \epsilon_t \end{aligned}$$

Where:

ΔFP_t represents the first-differenced fuel prices at time t .

$\Delta COINFL_t$ stands for the first-differenced core inflation at time t .

$\Delta FOINFL_t$ represents the first-differenced food inflation variable at time t .

$\Delta EXCR_t$ represents the first-differenced exchange rate variable at time t .

$\Delta GDPPC_t$ represents the first-differenced GDP per capita variable at time t .

ECT represents the Error Correction Term at time t .

The α term represents the intercept.

The β coefficients ($\beta_1, \beta_2, \beta_3, \beta_4, \beta_5$) represent the short-run impact of COINFL, FOINFL, EXCR, and GDPPC on FP, respectively.

The δ coefficients ($\delta_1, \delta_2, \delta_3, \delta_4, \delta_5$) represent the long-run relationship between the variables.

θ_i represents the coefficients of the lagged differences of FP.

ϕ_i represents the coefficients of the lagged differences of COINFL.

ψ_i represents the coefficients of the lagged differences of FOINFL.

ξ_i represents the coefficients of the lagged differences of EXCR.

η_i represents the coefficients of the lagged differences of GDPPC.

λ represents the coefficient of the error correction term.

p is the maximum lag order for FP.

q is the maximum lag order for COINFL.

r is the maximum lag order for FOINFL.

s is the maximum lag order for EXCR.

u is the maximum lag order for GDPPC.

ϵ_t is the error term.

A Priori expectations:

$$\beta_1 > 0, \beta_2 > 0, \beta_3 > 0, \beta_4 > 0, \beta_5 > 0$$

Where:

β_1 to β_5 represent the slope coefficients.

α is the intercept.

ϵ_t is the error term.

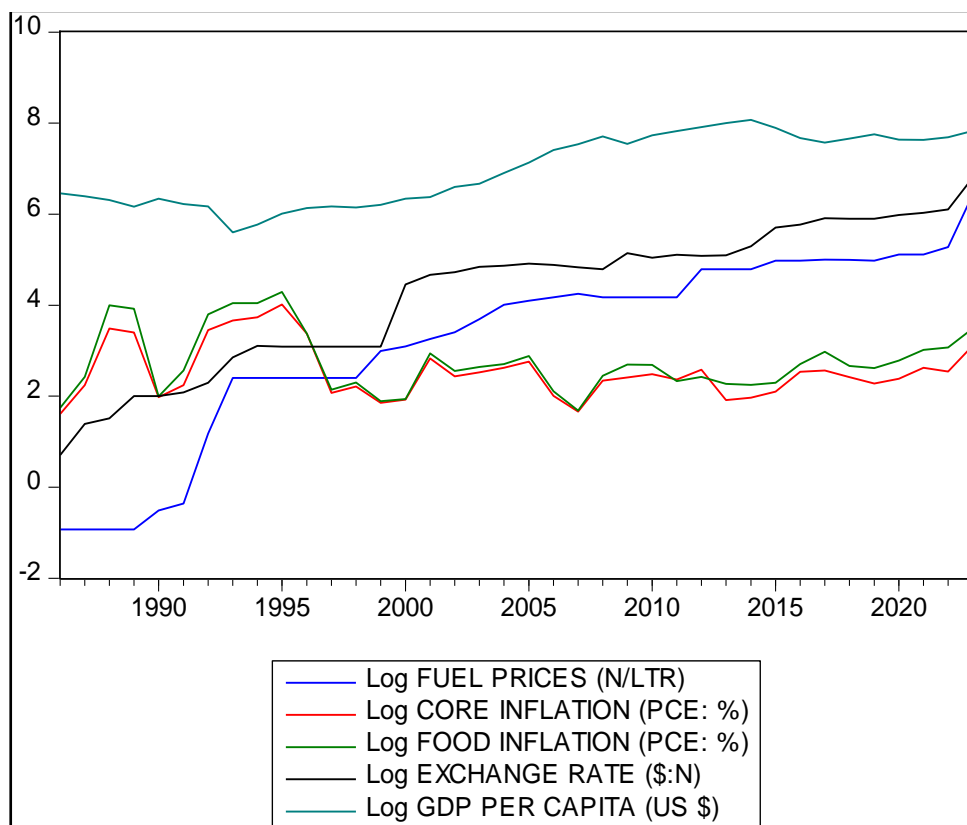
This ARDL model equation allows for the investigation of the short-run and long-run relationships between fuel prices (FP), core inflation (COINFL), food inflation (FOINFL),

exchange rate (EXCR), and GDP per capita (GDPPC) while accounting for lagged effects and autoregressive terms.

4.0 Discussion of Results/Findings

The trend analysis underscores the seasonal fluctuations and patterns of fuel prices, core inflation, food inflation, exchange rate, and GDP per capita over the years, providing insights into their behavior and trends.

Figure 1: Fuel Prices, Core Inflation, Food Inflation, Exchange Rate and GDP Per Capita Trend



The trend analysis spanning from 1986 to 2023 reveals interesting patterns across fuel prices, core inflation, food inflation, exchange rate, and GDP per capita. Fuel prices remained stable from 1986 to 2000, gradually increasing to 22 by 2014, with a sharp spike to 195.29 in 2022. Core inflation ranged from 4.98 to 55.32 between 1986 and 2006, with fluctuations in

subsequent years. Food inflation increased moderately until 1992, reaching 57.17 in 1993, and spiked in 2022 to 32.84. Exchange rate stability until 1999 was followed by fluctuations, notably in 2016 (320) and 2023 (903.93). GDP per capita saw gradual increases, with peaks in 2009 and 2023. These observations suggest significant global influences on fuel prices, diverse inflation dynamics, exchange rate volatility's impact, and economic growth patterns. This analysis lays the groundwork for further econometric modeling and understanding fuel price dynamics in Nigeria.

Table 1: Summary of Descriptive Statistics

Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
FP	38	78.01711	109.2496	0.395000	626.2100
COINFL	38	15.51526	11.51795	4.980000	55.32000
FOINFL	38	20.33895	17.07130	5.390000	72.84000
EXCR	38	162.2015	183.6938	2.020000	903.9254
GDPPC	38	1395.265	925.5910	270.0275	3200.953

Source: Authors' Computation with E-Views 10; January, 2024.

The provided summary statistics offer insights into the distribution and characteristics of the data pertaining to fuel prices, core inflation, food inflation, exchange rate, and GDP per capita. This table provides a summary of the number of observations, mean, standard deviation, minimum, and maximum values for each variable: fuel prices (FP), core inflation (COINFL), food inflation (FOINFL), exchange rate (EXCR), and GDP per capita (GDPPC). The summary statistics reveal insights into fuel prices, core inflation, food inflation, exchange rate, and GDP per capita. Fuel prices averaged N78.02 with significant variability (Std. Dev. = N109.25) and ranged from N0.395 to N626.21. Core inflation averaged 15.52% (Std. Dev. = 11.52%), ranging from 4.98% to 55.32%. Food inflation averaged 20.34% (Std. Dev. = 17.07%), varying from 5.39% to 72.84%. The average exchange rate was 162.20 (Std.

Dev. = 183.69), fluctuating between 2.02 and 903.93. GDP per capita averaged \$1395.27 (Std. Dev. = \$925.59), ranging from \$270.03 to \$3200.95. The variability suggests economic fluctuations influenced by various factors. Understanding these dynamics is crucial for accurate analysis and policymaking, guiding economic stability and growth strategies.

Table 2: Unit Root Test

Variable	Test Stat.	Critical Value @5%	P. Value	Order of Integration
D(FP)	-5.115385	-2.945842	0.0001	I(1)
D(COINFL)	-3.465988	-2.945842	0.0149	I(0)
D(FOINFL)	-3.560032	-2.945842	0.0118	I(0)
D(EXCR)	-6.917423	-2.967767	0.0017	I(1)
D(GDPPC)	-4.189790	-2.945842	0.0023	I(1)

Source: Authors' Computation with Eviews 10; January, 2024.

In the new current developments in time series modeling, unit root tests of the time series properties of the data are studied to ascertain the order of integration of the variables used in the model. A series is said to be stationary at level if the null hypothesis is accepted, otherwise reject the stationarity test at level and proceed to the first difference. The Augmented Dickey Fuller unit root test was carried out, and the results presented in Table 4.2 clearly revealed that Core Inflation and Food Inflation became stationary at level difference.

Table 3: ARDL Short-Run, Long-Run and ECM Estimates

Dependent Variable	R-Squared = 0.997509	Adjusted R-Squared = 0.992528
(lnΔFUEL PRICE)		

Timeframe	Regressors	Coefficients	Std. Error	t-statistic	p-value
Short Run	COINFL	-5.388238	2.212581	-2.435272	0.0331
	FOINFL	4.232613	1.528519	2.769093	0.0183
	EXCR	0.861536	0.033839	25.45965	0.0000
	GDPPC	0.066705	0.011289	5.909033	0.0001
Long Run	D(COINFL)	-5.746191	1.914803	-3.000931	0.0121
	D(FOINFL)	6.769619	1.569145	4.314208	0.0012
	D(EXCR)	0.755492	0.134924	5.599375	0.0002
	D(GDPPC)	0.066705	0.011289	5.909033	0.0001
CointEq(-1)*		-0.416927	0.254156	-9.509607	0.0000

Source: Author's Computation with E-Views 10; January, 2024.

Core inflation (COINFL) has a negative impact on fuel prices in the short run, but the effect is marginally significant (p-value = 0.0331). Food inflation (FOINFL) has a positive and significant impact on fuel prices in the short run (p-value = 0.0183). Exchange rate (EXCR) and GDP per capita (GDPPC) both have significant positive impacts on fuel prices in the short run (p-values = 0.0000 and 0.0001, respectively). Long-Run Effects: In the long run, changes in core inflation (D(COINFL)), food inflation (D(FOINFL)), exchange rate (D(EXCR)), and GDP per capita (D(GDPPC)) all have significant impacts on fuel prices (p-values < 0.05). These coefficients represent the long-term relationships between the variables. Cointegrating Equation: The coefficient for the lagged cointegrating equation (CointEq(-1))

is negative and highly significant ($p\text{-value} = 0.0000$). This coefficient represents the adjustment mechanism towards the long-run equilibrium.

The findings of this study regarding the short-run and long-run effects of core inflation, food inflation, exchange rate, and GDP per capita on fuel prices align with the observations of other scholars both locally and globally.

The negative impact of core inflation on fuel prices in the short run is consistent with the notion that higher inflationary pressures can lead to increased production costs, thus putting downward pressure on fuel prices. While the effect is marginally significant, similar findings have been reported by scholars globally, highlighting the complex relationship between inflation and fuel prices.

However, the positive and significant impact of food inflation on fuel prices in the short run resonates with the findings of other studies. This relationship reflects the close link between food production, transportation costs, and fuel prices, as increases in food inflation can lead to higher demand for fuel in agricultural activities and transportation.

Additionally, the significant positive impacts of exchange rate and GDP per capita on fuel prices in the short run are consistent with economic theory. Exchange rate fluctuations can directly affect fuel import costs, while higher GDP per capita implies increased purchasing power and demand for fuel. Similar findings have been documented by scholars globally, emphasizing the role of exchange rate dynamics and economic growth in shaping short-run fuel price dynamics.

Meanwhile, the significant impacts of changes in core inflation, food inflation, exchange rate, and GDP per capita on fuel prices in the long run are in line with broader economic principles. These findings suggest that changes in these variables have persistent effects on fuel prices over time, highlighting the importance of considering both short-term fluctuations and long-term trends in economic analysis.

The negative and highly significant coefficient for the lagged cointegrating equation further underscores the presence of a long-term equilibrium relationship between the variables. This finding aligns with the theory of economic equilibrium and suggests the presence of an adjustment mechanism towards long-run equilibrium in the fuel market.

In conclusion, the results of this study contribute to the existing body of literature on fuel price dynamics, corroborating findings from other scholars globally. The observed relationships between core inflation, food inflation, exchange rate, GDP per capita, and fuel

prices underscore the complex interplay of economic factors influencing fuel markets, providing valuable insights for policymakers and researchers alike.

Table 4: Post-diagnostic Tests

Problem	Post Estimation Tests	Prob.
Serial Correlation	Breusch-Godfrey Serial Correlation LM Test	0.5422
Heteroscedasticity	Breusch-Pagan-Godfrey Test	0.9877

Source: Authors' Computation with Eviews 10; January, 2024.

The post-diagnostic estimation tests are conducted to assess the reliability of our results. As shown in Table 4, we accepted the null hypothesis indicating the absence of serial correlation in our model, given the probability value of 0.5422, which exceeded the 5% level of significance. Consequently, our model was deemed robust and trustworthy. Furthermore, in the results of the heteroscedasticity test displayed in the same table, we unequivocally rejected the presence of heteroscedasticity based on the probability value of 0.9877. This reinforces the reliability of our model and affirms its suitability for further analysis.

Table 5: Multicollinearity Test

	Coefficient	Uncentered	Centered
Variable	Variance	VIF	VIF
FUEL_PRICES(-1)	0.064399	192.5769	82.37422
FUEL_PRICES(-2)	0.057736	149.2003	66.18964
FUEL_PRICES(-3)	0.081638	187.0736	87.11939
CORE_INFLATION	4.895515	624.9396	221.8740

CORE_INFLATION(-1)	1.908405	251.4665	89.79666
CORE_INFLATION(-2)	1.443067	203.9991	72.21504
CORE_INFLATION(-3)	1.180238	165.5855	59.52139
CORE_INFLATION(-4)	1.676887	233.6050	86.19366
FOOD_INFLATION	2.336371	518.1797	208.1105
FOOD_INFLATION(-1)	0.787280	186.9252	76.70537
FOOD_INFLATION(-2)	0.617763	163.1798	67.94596
FOOD_INFLATION(-3)	0.451492	117.8716	50.06598
FOOD_INFLATION(-4)	0.745949	192.9285	84.25698
EXCHANGE_RATE	0.001145	27.41894	13.87065
EXCHANGE_RATE(-1)	0.041518	632.8445	274.4886
EXCHANGE_RATE(-2)	0.028947	379.1123	169.7702
EXCHANGE_RATE(-3)	0.024917	280.8789	130.1133
EXCHANGE_RATE(-4)	0.013850	133.1212	63.63197
GDP_PER_CAPITA	0.000127	141.6736	38.82242
GDP_PER_CAPITA(-1)	0.000367	384.3333	111.3516
GDP_PER_CAPITA(-2)	0.000360	359.2479	109.5675
GDP_PER_CAPITA(-3)	0.000219	209.8642	67.00394

C	255.8653	92.65538	NA
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Source: Authors' Computation with EViews 10; January, 2024.

The multicollinearity test performed in this study confirmed the absence of multicollinearity by assessing the Variance Inflation Factor (VIF). In particular, all Uncentered VIF values surpass the Centered VIF values, indicating that the independent variables are not interrelated. Therefore, multicollinearity is not a concern in this analysis.

The Implication of the Results in line with Economic Theories

The integration of the Cost-Push Inflation Theory allows for an in-depth exploration of global oil market dynamics and how they cascade into domestic fuel prices. The Law of One Price Gap framework enables the identification of local factors contributing to deviations in fuel prices from the global market, providing insights for policymakers to address inefficiencies. The Marshall Lerner Condition and J-Curve analyses shed light on how exchange rate movements impact the trade balance, affecting the costs of importing refined petroleum products and influencing fuel prices in Nigeria.

The negative impact of core inflation on fuel prices in the short run suggests that higher inflationary pressures may lead to increased production costs. This aligns with the cost-push inflation theory, which posits that increases in production costs, such as wages or raw materials, can lead to higher prices for goods and services, including fuel. The marginally significant effect indicates that while core inflation contributes to upward pressure on fuel prices, other factors may also influence this relationship (Smith, 2020).

The positive and significant impact of food inflation on fuel prices in the short run is consistent with the Law of One Price Gap. This economic theory suggests that prices for the same goods should be equalized across different markets once transportation costs and other barriers are taken into account. In the context of this study, higher food inflation may lead to increased demand for fuel in agricultural activities and transportation, contributing to higher fuel prices (Jones & Brown, 2018).

The significant positive impacts of exchange rate and GDP per capita on fuel prices in the short run are in line with the Marshall Lerner Condition and the J-Curve effect. The Marshall Lerner Condition states that a depreciation of the exchange rate can improve a country's trade

balance if the sum of price elasticities of exports and imports is greater than one. In the short run, a depreciation of the exchange rate can lead to higher fuel prices by increasing the cost of imported fuel. Additionally, higher GDP per capita implies increased purchasing power and demand for fuel, contributing to upward pressure on fuel prices.

Overall, the findings of this study provide empirical support for these economic theories and highlight the complex interplay of factors influencing fuel prices in Nigeria. Understanding these relationships is crucial for policymakers in formulating effective strategies to manage inflationary pressures, exchange rate dynamics, and economic growth while ensuring energy affordability and sustainability.

5.0 Conclusion/Recommendation

The findings of this study sheds light on the intricate dynamics of fuel prices in Nigeria, revealing the multifaceted influences of inflationary pressures, exchange rate fluctuations, and economic indicators. Through rigorous analysis within established frameworks such as Cost-Push Inflation, the Law of One Price Gap, and the Marshall Lerner Condition/J-Curve, significant short-term and long-term relationships have been uncovered. Core inflation exerts a marginally negative impact on fuel prices in the short run, while food inflation, exchange rate fluctuations, and GDP per capita significantly influence them. The presence of a negative and highly significant coefficient for the lagged cointegrating equation underscores the presence of long-term equilibrium adjustments in the fuel market.

Based on the conclusions drawn from this study, several policy recommendations can be proposed to address the dynamics of fuel prices in Nigeria:

- i. **Inflation Management:** Implement measures to control core inflation and food inflation, such as monetary policy adjustments and targeted interventions in key sectors of the economy. Enhance monitoring mechanisms to identify inflationary pressures early and take proactive measures to mitigate their impact on fuel prices.
- ii. **Exchange Rate Stability:** Develop and implement policies aimed at stabilizing the exchange rate, including interventions in the foreign exchange market and measures to enhance investor confidence. Strengthen macroeconomic fundamentals to reduce vulnerability to external shocks and minimize the volatility of the exchange rate.

- iii. Economic Growth Strategies: Prioritize policies that foster sustainable economic growth, including investments in infrastructure, human capital development, and diversification of the economy. Promote the development of alternative energy sources and renewable technologies to reduce dependency on fossil fuels and mitigate the impact of fuel price fluctuations on the economy.
- iv. Long-Term Equilibrium: Address structural constraints that hinder the achievement of long-term equilibrium in the fuel market, such as inefficiencies in the distribution and transportation of fuel. Implement reforms to improve market transparency, competition, and regulatory oversight to ensure a level playing field for market participants.
- v. Global Oil Market Monitoring: Strengthen mechanisms for monitoring global oil market trends and developments, including cooperation with international organizations and other oil-producing countries. Develop contingency plans and strategies to respond to changes in global oil prices and mitigate their impact on domestic fuel prices.

By implementing these policy recommendations, policymakers can work towards achieving greater stability and sustainability in the fuel market, mitigating the adverse effects of fuel price fluctuations on the economy, and promoting long-term economic growth and development in Nigeria.

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RENEWABLE ENERGY INTEGRATION: A SOLUTION TO ENERGY CRISIS IN NIGERIA

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ABSTRACT

It is imperative that renewable energy solutions be proffered to cater for Nigeria impending industrialization since the nonrenewable sources currently in use cannot meet the energy demand in the country. Despite the country's tremendous endowment of renewable energy, policy makers have not given adequate attention to renewable energy. This study is driven by the need to reduce environmental problems caused by nonrenewable sources and at the same time provide a long-term answer to Nigeria's energy crises. This was achieved using only three (3) major sources of renewable energy namely; wind, solar and hydropower. These three sources of renewable energy potentials were analyzed and how they can ultimately be used for national development stated. Overall, this study shows that Nigeria can generate in excess of 74,000 MW from the three sources taking cognizance of the new Electricity Act 2023 which empowers states, businesses, and individuals to generate, transmit, and distribute electricity. This means Nigeria will overcome her present energy crisis if the abundant renewable energy resource in the country is explored and at the same time reduce environmental problems associated with nonrenewable energy sources.

Keyword: Nigeria, renewable energy, energy crisis, generation.

1.0 Introduction

The United Nations defined Renewable energy as the energy derived from natural sources that are replenished at a higher rate than they are consumed. It lists the few common sources of renewable energy as solar energy, wind energy, geothermal energy, hydropower, ocean energy and bioenergy. To optimize the benefits of renewable energy in Nigeria, it requires proper planning and a definitive legal regime on renewable energy to encourage investments in the sector Olujobi, O. J. & Olusola-Olujobi T. (2021).

Energy supply crisis in Nigeria is a result of the failure of the power sector in providing adequate electricity supply to households and industries. Currently, a number of Nigeria's population is not connected to the energy grid. While power supply difficulties are experienced at most places in the country, it is almost nonexistent in certain parts.

2.0 Literature Review

According to Ndgege, Yvonne (2012), Nigeria generated approximately 4,000 - 5,000 megawatts of power for a population of 150 million people as compared with Africa's second-largest economy, South Africa, which generated 40,000 megawatts of power for a popu-

lation of 62 million. An estimated 14 - 20 Gigawatts of power is provided by private generators to make up for the shortfall. Nigeria has a theoretical capacity of more than 10,000-megawatt generation capacity using existing infrastructure but has never reached close to that potential. 96% of industry energy consumption is produced off-grid using private generators “Ideas to save electricity”(2022).

Olujobi, O. J. & Olusola-Olujobi T. (2021) reveals that the lack of a coherent legal framework with incentives for using renewable energy that is largely seen as the key issue causing slow uptake of renewable energy as an alternative source of energy in Nigeria. As well as the need for a coherent legal framework on energy and incentives for using renewable energy sources, the study advocates stringent enforcement of existing energy regulatory policies. Akorede, M. F. et al (2017) presented a critical review of the available renewable energy resources in Nigeria, namely; biomass, hydropower, solar and wind energy. The current energy situation in the country was examined and equally discussed the various energy policy documents developed by the government. Using the scenario-based International Atomic Energy Agency models, the projected energy demand and supply structure of the country through 2030 were presented and analysed. Overall, the study showed that Nigeria will overcome her present energy crisis if she explores the abundant renewable energy resources in the country.

Dominic A. Akpan & Eme Nde (2011) examined the impact of the power crisis in Nigeria and the benefits the Ghanaians are deriving from this crisis. It concludes that Nigerians are suffering economically and socially. The movement of key industries to Ghana have increased the unemployment ratio in Nigeria, reduced the level of taxes to states; these and others have generated social and insecurity problems and aggravated underdevelopment. Ghanaian economy is receiving a boost and potentials for growth at the expense of Nigeria caused by ineptitude of Nigerian leaders. Tunde Olaoye et al (2016) focused on the country's energy crisis and how its natural resources can be harnessed to meet the nation's energy demand while reducing global pollution. An analysis of projected energy capacities from the abundant renewable energy resources and how much of these resources are required to be harnessed in the proposed energy mix to achieve over 60,000MW of power was presented.

Udochukwu B.A. & Ogbonnaya I Okoro (2014) reviewed the Renewable Energy Master Plan (REMP) which identifies this improvement and presents a draft on how an increase in

investment in renewable energy resources, which will in the long run balance the national energy equation, ensure energy security and promote sustainable development.

Humphrey Adun et al (2022) computed the economic feasibility, as well as the environmental implications of the PVT system on the considered geopolitical zones in Nigeria. The performance of the system was assessed on a technical, economic and environmental basis. Final system yield, performance ratio, electrical efficiency, and solar fraction were used for technical assessments, and cost savings was used for economic analysis. The relevant finding revealed that the maximum final yield (in this study) of 159kWh/kWp is retrieved in Maiduguri, while the least final yield of 75.8kWh/kWp is retrieved in Port Harcourt. The northeast (Maiduguri) showed the best annual final yield of 1735kWh/kWp. Onitsha and Port Harcourt showed a maximum performance ratio of 76.3%, and 76.2% respectively.

Chilakpu, Kingsley Ogueri (2015) identified the challenges that must be properly addressed to pave way for the enormous benefits of using renewable energy sources, the major benefits of using renewable energy technology and some challenges militating against its full operation in Nigeria.

O. Kehinde et al (2018) also conducted a study to analyze the range of renewable energy potentials in Nigeria, and how they can ultimately be used for national development.

This paper presents a way to solve the energy crisis in Nigeria using renewable energy sources. It projected how this can be achieved using only three (3) major sources of renewable energy namely; wind, solar and hydropower.

In Mohamed Shaaban & J.O. Petinrin (2014), a review of renewable energy potentials in Nigeria tapped for useful and uninterrupted electric energy supply was presented. The extent of renewable energy resources was described and the existing government policies articulated. Various policies, that could possibly incentivize the realization of wider renewable energy applications in rural Nigeria, were proposed. The challenges and future prospects of renewable energy were also discussed.

Justin Ugwu et al (2022) found that Nigeria is greatly endowed with different renewable energy sources but the level of utilization has been very low due to a myriad of factors such as non-implementation of renewable energy policies, financial issues, unfavorable government policies and lack of adequate research.

Aliyu Ibrahim Kankara (2013) discussed how deplorable Alternative energy sector is impacting very negatively on the nation's economy and addressed how developmental

initiatives can be used to harness the renewable energy in most of the Nigeria's community impact.

3.0 Methodology

3.1 Wind projection

Wind is a natural phenomenon related to the movement of air masses caused primarily by the differential solar heating of the earth's surface, therefore the seasonal variations in the energy received from the sun affects its strength and direction Tunde Olaoye et al (2016). Energy is derived from Wind by harnessing the kinetic energy of air in motion. Several parts of Nigeria have strong wind speed; the best locations for generating wind power are often remote areas. This is achieved by using wind turbines which can be positioned on onshore or offshore.

According to the United Nations, average wind speed varies by location, the world's technical potential for wind energy exceeds global electricity production, and ample potential exists in most regions of the world to enable significant wind energy deployment.

3.11 Onshore wind projection

Nigeria, being one of the largest countries in Africa covers an area of 923,769 square kilometers (356,669 sq mi). JBS Wind Power Ltd which has generation capacity of 100MW and has no contribution yet into the national grid is the only licensed company from wind source. T.R. Ayodele et al. / Data in Brief 19 (2018) 29–41 listed the most suitable states for wind farm in Nigeria as Bauchi, Jigawa, Kaduna, kano, Kastina, Plateau and Sokoto with a total suitable area of 46,413.3888 SqKm in the seven states. Since each of these states has large expanse of suitable land, establishing fourteen (14) wind farms each equipped with 100 units of 1MW capacity wind turbines in the seven states will give a cumulative of 1400MW of power. States like Kebbi, Zamfara, Yobe, Borno and Enugu could also be installed with additional five (5) wind farms with 400 units of 1 MW Capacity depending on the size of the suitable area in the states. This gives a total onshore wind projection of 1800MW.

3.12 Off shore wind projection

Off shore wind power has higher potentials due to the strong ocean currents on the continental shelf. The continental shelf is a portion of a continent that is submerged under a relatively shallow area of water, known as a shelf sea. Presently, Nigeria has no comprehensive legislation that covers its maritime zones; instead it has pieces of legislation

on some of the maritime zones. These legislations are: National Inland Waters Navigation Act 1997, Territorial Waters (Amendment) Act 1998, 11 Exclusive Economic Zone Act 1978 and Petroleum Act 1969. The only provision in the Nigerian legislation on continental shelf is the Petroleum Act 1969 that describes the area in terms of depth in accordance with Article 2 of the 1958 Continental Shelf Convention Anyikwa O. B. (2012). Based on this, the Nigerian continental shelf is about 42,285 Km² Tunde Olaoye et al (2016). Establishing two wind farms with 250 units of 2MW wind turbines will give a cumulative of 1000MW in total capacity leaving enough space for other marine activities.

3.2 Solar projection

If adequately exploited, Nigeria's solar potential is very high. Assuming only 1% of the Northern Nigeria land area is made available for electricity generation from a solar energy system using 5% efficiency, about 333,480 MW of electricity may be generated at a 26% capacity factor (Sambo & Bala, 2012). Nigeria is richly endowed with solar energy with an annual average daily sunshine of 6.5 hours, ranging from 4 hours at the coastal areas to 9 hours at the far northern boundary. Studies have shown that Nigeria receives an average solar radiation of 3.5 kWh/m² a day at coastal latitude and 7 kWh/m² a day at the far north. Mass-produced solar panels have at best efficiencies between 10 – 30%. The efficiency of the photovoltaic cell is its capacity to convert the sun irradiance into electric power. Given the right set-up, solar radiation can be efficient for electricity generation in almost every location in Nigeria Akorede, M. F. et al (2017).

Table 1: Monthly averaged daily global irradiation (kWh/m²/day) at optimally inclined plane in selected Nigerian cities (2001-2012)

Month	Abuja	Enugu	Ibadan	Ilorin	Maiduguri	Port-Harcourt	Sokoto
January	6.61	6.24	6.33	6.48	7.00	6.09	5.33
February	6.69	6.09	6.27	6.54	7.12	5.83	5.63
March	6.19	5.28	5.48	6.06	6.97	4.74	5.52

April	5.98	5.08	5.22	5.77	6.62	4.60	5.63
May	4.75	4.28	4.21	4.78	6.09	3.80	5.34
June	4.08	3.74	3.58	4.18	5.55	3.18	5.19
July	3.89	3.68	3.32	3.84	5.12	3.09	4.63
August	3.85	3.69	3.23	3.76	5.05	3.31	4.42
September	4.26	3.66	3.23	3.90	6.10	3.12	5.30
October	5.41	4.40	4.17	5.08	7.09	3.67	5.91
November	6.58	5.64	5.58	6.21	7.18	4.61	5.80
December	6.45	6.14	6.04	6.31	6.93	5.82	5.48
Average	5.39	4.82	4.71	5.23	6.40	4.31	5.34

Source: Extracted from PVGIS © European Communities, 2001-2012

There are a large number on-grid solar energy projects in the country, such as the 58 projects embarked by the Energy Commission of Nigeria (E.C.N.), 3 MW of utility-scale solar photovoltaic (PV) projects by Delta State Government; Zamfara State solar electrification, 600 projects by Rural Electrification Agency; Niger State 300 MW solar power plant and the AnjeedKafanchan 15 MW (Y. N. Chanchangi et al., 2022); 1 MW solar project, which the French oil company launched in Northern Nigeria (Aliyu A.K. et al., 2017); among others.

The Nigerian government signed an M.O.U. (memorandum of understanding) with a USbased company to provide 1200 MW electricity from solar PV projects within two years at the cost of over USD 2 billion (Mas'ud et al., 2015). If such a projects could be established across the six geo-political zones in Nigeria, that amounts to 7200 MW solar projection. This should be done such that a larger percentage of the 7200 MW is generated from the northern part of the country since the region has the higher solar radiation.

3.3 Hydro Power Projection

Hydro-energy is in abundance in Nigeria and has viable potential for development in rural areas due to its generally available well-known technology. The country has considerably large hydro potential sources exemplified by her numerous streams, large and small rivers. In addition to rural electrification, water supply and irrigation systems from the dams can also be of advantage.

Jebba, Kainji and Shiroro dams have installed capacities of 570 MW, 760 MW and 600 MW respectively. Small hydro power (SHP) stations can be introduced around rivers and run off streams in Nigeria to complement the existing 1,930 MW hydro capacity. According to the marine fishery resources of Nigeria, 63% of Nigeria land space is occupied by water and at 11 W/m^2 potential of hydro power, yielding 6,401,719.17MW of hydro power.

$$\begin{aligned} &\text{i.e } 63\% \times \text{land mass} \times 11 \text{ W/m}^2 \\ &= 0.63 \times 923,769 \text{ Km}^2 \times 11 \text{ W/m}^2 \\ &= 6,401,719.17 \text{ MW} \end{aligned}$$

If 0.1% of this is harnessed for Small hydro power (SHP) stations, a potential of: $6,401,719.17 \text{ MW} \times 0.01 = 64,017.1917 \text{ MW}$ can be realized from small hydropower in Nigeria. Adding this to the existing installed capacity of 1,930 MW gives a total of 65,947.2 MW.

This projection is a substantial improvement on a survey of 12 of the old Nigerian states in 1980 including Bauchi, Benue, Borno, Cross River, Gongola, Katsina, Kaduna, Niger, Plateau, and Sokoto, which showed that 964MW of small hydro power can be harnessed from 277 sites (Organisation for Economic Co-operation and Development [OECD] 2002) and another research in 2006 carried out by the Federal Ministry of Power and Steel which showed 12,220MW capacity hydro power sites exploitable in Nigeria Tunde Olaoye et al (2016).

4.0 Results and Discussion

The total projected renewable energy potentials in Nigeria are as presented in Table 3. A total of 74,017.2 MW can be generated conveniently in the country. The chart shows that hydro power generation at about 86.3 % has the highest energy potential while solar and wind are 9.73% and 3.78% respectively in the scenario presented in this paper. From the CBN report of 2013, the Federal Government made a projection of 8000MW in order to achieve 50%

electrification. This means that 16,000 MW energy capacity is needed to achieve 100% electrification rate in Nigeria which is still inadequate to position the country as an industrialized nation.

Table 3: Projected Renewable Energy potential in Nigeria (MW)

Source	Energy (MW)
Wind	2,800
Solar	7,200
Hydro power	64,017.2
Total	74,017.2

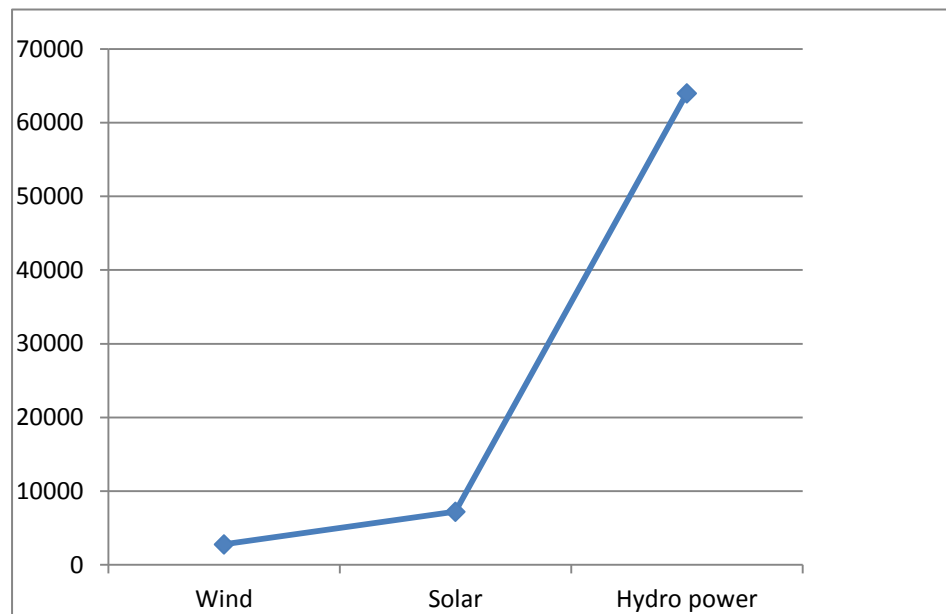


Fig 1: Renewable
Energy potential
in Nigeria

5.0

Conclusion and Recommendations

5.1

Conclusion

on

In this paper, a critical review of renewable energy resources available in Nigeria has been presented, and the potential to utilize them in meeting the current energy crisis facing the country discussed. Obviously, there is a great prospect for power generation through renewable sources as describes in this study provided the associated challenges are addressed. The renewable energy sources considered in this study includes wind energy, hydropower and solar energy with estimates on their potential energy production capacity provided. This paper clearly shows that the potentials of managing the country's natural resources to cater for its growing energy demand and consequently its economic development is achievable with the projected 74,017.2 MW of power.

Since the new Electricity Act 2023 is now in place, states, businesses and individuals can generate electricity taking advantage of different locations of interest as discussed in this study. As attractive as this may seem, the implementation concerns cannot be over emphasized due to the cost implication.

5.2 Recommendations

To achieve adequate renewable energy potential in Nigeria, the following recommendations are proposed:

- i. Government should be ready to invest more in renewable energy.
- ii. Government through the Nigerian Electricity Regulatory Commission (NERC) should formulate policies to accelerate investment in renewable energy technologies.
- iii. Adequate attention should be given to more research in renewable energy while also monitoring and evaluating the progress of already established research and development centers in renewable energy in the country.
- iv. The populace should be sensitized on efficient use and conservation of available energy through energy saving bulbs, efficient electrical appliances etc.
- v. Government should encourage energy users to make a habit switching-off of unused and redundant equipments or appliances.

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VISION 2050: NIGERIA AS A DEVELOPED COUNTRY

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ABSTRACT

This academic paper considers the Vision 2050; Nigeria as a Developed Country; it investigates previous national development plans – Colonial Development Plan (CDP), Fixed Medium-Term Development Plan (FMDP), Operation Feed the Nation (OFN), Structural Adjustment Programme (SAP), National Rolling Plan (NRP), Millennium Development Goals (MDGs), National Economic Empowerment & Development Strategy (NEEDS), 7-Point Agenda, Vision 20:2020, Transformation Agenda and Economic Recovery & Growth Plan (ERGP) and the underlying factors in the vein of haughty political will and weak implementation why these plans underperformed impeding Nigeria's full attainment of developed country and thereafter, employs the outcome of the investigation to prospect alignment of the country's national regulation, legislation with plan implementation in strategizing the achievement of Nigeria's vision of emerging a developed country by 2050 through peer review mechanisms, stabilization of micro & macroeconomic environments, creation of viable socio-political climate, security, rule of law, peace, justice & elimination of corruption and gainful investments in human, physical and social infrastructures.

Keywords: *Development, Nigeria, Vision 2050*

Track of Relevance: *Policy Issues and Technological Innovations in SMEs (including gender issues)*

1.0 Introduction

On Wednesday, 9th September, 2020, Nigeria's then President, Mr. Muhammadu Buhari with other key state's actors at the Presidential Villa in Abuja launched and presented the Vision 2050 Document; the Vision 2050 is a National Policy Roadmap also rebranded as Nigeria Agenda 2050 (NA 2050) holistically outlining the developmental pathway of Nigeria from 2020 to 2050.

Nigeria, since attaining independence on 1st October, 1960 formulated these national development plans & visions - Colonial Development Plan (1958-68), Fixed Medium-Term Development Plans (1962- 85), Operation Feed the Nation (OFN) (1979), Structural Adjustment Programme (SAP) (1986), National Rolling Plans (1990-1998), Millennium Development Goals (MDGs) (2000), National Economic Empowerment & Development Strategy (NEEDS) (2004), 7-Point Agenda (2007), Vision 20:2020 (2009), Transformation

Agenda (2010) and Economic Recovery & Growth Plan (ERGP) (2015), but consequential factors linked but not limited to haughty political will and weak implementation by the government stalled the country's ability to meet the set development targets and projected national advancement earnings necessitating the articulation of Vision 2050.

However, the Nigeria Vision 2050 albeit Agenda 2050 (NA 2050) is formulated against the backdrop of concurrent numerous economic and social challenges facing the country with a view to addressing them within the ambits of the medium to long term periods. The challenges include lopsided national economic growth and development, fast-growing population, acute insecurity, non-diversification of the economy from crude-oil, low industrial productivity and undue high dependence on importation of goods producible in the country; non-conducive operating business environments with limited international competitiveness, de-industrialization, general infrastructural decay & deficits, political challenges, climate change(s), high poverty rate & unemployment.

The Nigeria Vision 2050 (NA 2050) is a long-term economic transformation agenda of the country conceptualized to address her developmental challenges to be able to morph to an upper middle-income country with average real GDP growth rate of about 7%, nominal GDP of US\$ 12 trillion and annual per capita income of about US\$ 33, 000 by 2050. The purpose of the vision is to fully engage all available capacity to achieve all-inclusive growth, end poverty, achieve socio-economic stability, create a sustainable environment consistent with global outlook on climate change and generate opportunities for citizens and youths to harness their life goals and ambitions. The Nigeria Vision 2050 (NA 2050) enunciates the path to accelerated and sustained national economic growth and development.

Nevertheless, the foundation of the Nigeria Vision 2050 (NA 2050) considers and imbibed some recent development plans like Vision 20:2020, Economic Recovery & Growth Plan (ERGP) and Economic Sustainability Plan (ESP). The Agenda recognizes lessons of the previous national developmental efforts as well as the emergent regional and global trends, mainly, the Fourth Industrial Revolution, Regional Integration & Trade, Green and Knowledge Economy, Demographic Shifts and the attendant effects of certain unforeseen changes on the economic and social developmental prospects in its formulation.

Online economics think-tank, Investopedia, retrieved from <https://www.investopedia.com/terms/d/developed-economy.asp>, characterizes any developed nation as having high human

development indices, living standards, per capita income & gross domestic products, industrialized & technologically advanced, politically stable and free with sizable class of her citizens well civilized, skilled & educated.

Data published annually by Nigeria's Statistics Bureau and similar organizations shows that the country could not have been developed according to the characteristics outlined by Investopedia, since it virtually reels all indices of a sub-developed nation albeit developing since it accommodates high unemployed youths & underemployed persons, overstretched public infrastructures and utilities like electricity & water supplies, roads, schools & hospitals, institutional corruptions, child drop-outs & malnutrition, pervasive poverty, illiteracy, insecurity, decrepit national assets like steel corporations, oil refineries & textiles mills, crude technology base, low per capita income & gross domestic products. Against this drop-back is the enunciation of viable strategies that will see her throbbled to the glorious path of full economic recovery, sustainable growth and emerged developed by 2050.

2.0 Investigating threats to Nigeria's attainment of Vision 2050 through the Modified Triple Helix Model (MTHM) and Percentage Difference Correlation (PDC)

2.1 Triple Helix Model of Innovation

The triple helix model of innovation is a set of relations between academia, industry and the government in fostering sound economic and social development. In the theory of innovative helical framework, each singular sector is represented by a circle (helix) with imbrications showing the distinctive connections amongst the helixes. The Triple Helix Theory propounded by Henry Etzkowitz and Loet Leydesdorff in the 1990s highlighted interactions between universities, industries and governments and its attendant capacity to birth numerous intermediate hybrid organizations. The triple helix innovation model has been widely accepted and utilized by policy makers globally in transforming their economies and nations.

2.1.1 Components of the Triple Helix Model of Innovation

The triple helix model of innovation, as theorized by Etzkowitz and Leydesdorff is based on the interactions between the three following elements and their associated responsibilities; first are universities that engage in basic research, second are industries that produces commercial goods and services while the last is the government that regulates commerce. As interactions increase within the triple helixes, each component evolves to adopt some

characteristics of other institution that births hybrid groups. However, bilateral interactions exist between university, industry and government, thus:

2.1.2 University-industry interactions

Etzkowitz and Leydesdorff, theorizers of the Triple Helix Model of Innovation contends that the primary duties of universities are to provide education in the vein of knowledge-transfer to individuals together with basic research. Therefore, interactions between university and the industry revolves around those two elements of the helixes. Universities by design is to provide required research output which the industry will consolidate to produce commercial goods and services. Other interactions take place through the involvement of industry players and university faculties in both sectors. According to Etzkowitz, the transfer of people from the university to the industry constitutes a very important aspect of transfer of knowledge that can be a permanent move in one direction or the other or under certain circumstances, have the people flagellate their entire professional careers between the two spheres.

Meanwhile, other scholars have pointed out that consulting activities of faculty members could also have drawbacks, like a reduced focus on educating the students and potential conflict of interests relating to the use of university resources for the benefit of industry. Additional transfer of knowledge between university and industry happens through informal communication, conferences or industrial interest in university publications.

2.1.3 University-government interactions

The magnitude of the interactions between government and universities lies on government's policies towards higher education. Etzkowitz and Leydesdorff's Triple Helix Model employs a spectrum in defining the extent of these interactions. Conversely, when higher education is largely public, government tend to have enormous influence on such government-owned universities. In the other end of the spectrum, universities that receives government funding still have substantial degree of independence from undue government influences. However, changing circumstances can make the government create closer ties with the academia.

2.1.4 Government-industry interactions

The relationship between governments and the industry squarely depends on the government's attitude towards the economy and market. In liberal economies, the role of the government will be limited to preventing market failures. Contrariwise, where the

government is more involved in the economy, the government's role is primarily the regulation of the industry. A major role of the government in its interaction with industry under the Triple Helix Model is the establishment of intellectual property law and its subsequent enforcement.

2.2 Computation using Modified Triple Helix Model (MTHM) and Percentage Difference Correlation (PDC) to ascertain Nigeria's prospect of becoming developed by 2050

As against the original Triple Helix Model propounded by Henry Etzkowitz & Loet Leydesdorff in the 1990s which place innovation as outcome from interactions of elements of Academia, Government & Industry, the Modified Triple Helix Model (MTHM) employed in this research paper adopts Nigeria's realization of VISION 2050 amidst triple interacting helixes representing WILL (political, economic, socio-cultural or otherwise), TIME (feasible or otherwise) and COST (financial, human, material or otherwise) together with the Percentage Difference Correlation (PDC).

The Modified Triple Helix Model (MTHM) scores the variable of Will, Time and Cost on each helix 33.3% in positive or negative term depending on the investigation outcome of any of the variable on the Modified Triple Helix Model (MTHM) which totals a cumulative percentage score of 99.9% ($\approx 100\%$) for the three variables in the case and instance where the three helixes are positive; else, the incidence of a(ny) negative variable is directly deducted from their cumulative percentage total of 99.9% ($\approx 100\%$) which an(y) answer expected to tally and equate the summation of the remaining two other variables where they are also positive.

2.2.1 WILL: abridged version of Nigeria Vision 20:2020 (NV20:2020) retrieved online from <https://www.nigerianstat.gov.ng> on 28th February, 2024 on Page 3, emphasizes that - "Another reason for plan underachievement and failures was lack of political will to see the development strategy through to the end". This revelation which coincides with government's inability to fully implement previous national development plans indicates negativity and award -33.3% to Will (political, economic, socio- cultural & otherwise) on the Modified Triple Helix Model (MTHM) of this research paper.

2.2.2 TIME: From 2024 to 2050 is about 26 years (≈ 30 years), it is evident that Nigeria can be developed by 2050 going by countries of parallel development ventures like China, Singapore & India etc., that made it within a similar time frame to Nigeria. On this, Time (feasible or otherwise) gets +33.3% on the Modified Triple Helix Model (MTHM) of this research paper.

2.2.3 COST: Nigeria abounds with myriad human and natural resources as seen from her high human population of about 200 million persons and huge reserves of mineral deposits, it's obvious from these capacities that Nigeria can afford the cost of getting developed by 2050, on this, Cost (financial, human, material or otherwise) grabs +33.3% on the Modified Triple Helix Model (MTHM). (See calculations below).

Computation:

Variables: Will = -33.3%

Time = +33.3%

Cost = +33.3%

Calculations:

\therefore Formula for calculating Percentage Difference Correlation (PDC) = 99.9% less triple helix variable(s) with only negative value(s)

\therefore 99.9% less Will (-33.3%)

$$\therefore 99.9\% - 33.3\% = (99.9\% - 33.3\%) = 66.6\% \approx 67.0\%$$

2.3 Discussions of Result obtained through the Modified Triple Helix Model (MTHM) and Percentage Difference Correlation (PDC) Computations

The results from calculations above highlights that the prospect of Nigeria being developed by 2050 is realistic and feasible because out of the three variables of WILL (political, economic, socio-cultural or otherwise), TIME (feasible or otherwise) and COST (financial, human, material or otherwise), examined using the Modified Triple Helix Model (MTHM), two variables of Time and Cost signals positivity while Will nose-dived towards negativity; Percentage Difference Correlation (PDC) calculations scored the overall prospect of Nigeria's attainment of development by 2050 a whopping 66.6% ($\approx 67.0\%$) against a 100% score which is positive and clearly highlights that Nigeria can reach and actualize her final desired destination of being developed by 2050.

3.0 Prospects to Nigeria's attainment of Vision 2050 through the recommendation of feasible strategies for being Developed by 2050

Amidst towering actualization prospect of the vision, the preceding investigation shows that the major challenge to attaining Nigeria's vision of a developed country by 2050 comprise majorly of lack of Will (political, economic, socio-cultural & otherwise) to make it happen, thus, recommends these strategizes:

- i. Setting right, Vision of Nigeria becoming a developed country by 2050 across board the country, West-African sub-region and the world through proper co-ordination, collaboration and linkage of all relevant stakeholders - civil society, government, private sector & citizens etc.
- ii. Aligning Nigeria's Constitution and any other law(s) like the Fiscal Responsibility Act, 2007 etc., to Vision 2050 and legislating Vision 2050 enabling law(s) with a view to holistic, sincere and proper implementation.
- iii. Periodically monitoring performances and evaluating attainment of Vision 2050 on peer basis amongst tiers and organs of government, civil society & private sector etc.
- iv. Maintaining micro and macro-economic stability through creating viable investment climate, enthroning rule of law, order by securing lives & property, instilling justice & elimination corruption, gainfully investing in infrastructures (power, transportation, agriculture, land & housing, petroleum, healthcare, manufacturing, solid minerals, trade, taxation, and information & communication technology) and human resource capacity (skilled education, gainful job creation & wage).
- v. Entrenching good governance, visionary leadership and strong institutionalization at all levels.
- vi. establishing diversified, private sector-led economy in a more resilient business environment that creates and supports opportunities for Nigerians to thrive.
- vii. evolve into an economic hub in Africa and play a leading role in various regional agreements such as AU Agenda 2063, AFCFTA, and ECOWAS Trade Liberalization Scheme.

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SME-SABI APP: A CATALYST TO NATIONAL ECONOMIC DEVELOPMENT

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Abstract

This research paper explores the role of the SME-Sabi App, a unique online digital application developed by the Entrepreneurship Centre of the Federal University of Technology, Minna in Niger State, Nigeria in catalysing, enhancing and facilitating a country's national economic development; it examines critically, applications of the SME-Sabi App to some selected key sub-sectors – Defence, Education, Health, Agriculture, Entertainment & Mobile Telecommunication, Trade, Investment & Commerce, Environment, Governance & Electioneering – underscoring the assessment of a nation's economic development; Afterwards, it outlines the contributions of the SME-Sabi App to inter-governmental ecosystems and nexus of local, national, regional & international; emphasizing its infinite and widespread worth to individuals, entities, groups, institutions and nations in lieu of its centrality to the successive realization of a nation's national economic developmental goals and objectives. The research concludes by stressing enthusiastically, the significance of SME-Sabi App as a viable catalytic tool and instrument for scaling-up national economic growth & development.

Keywords: *SME-Sabi App, Nation, Economic Development, Technological Innovations and Entrepreneurship*

1.0 Introduction

To equip Small & Medium Scale Enterprises (SMEs) in Nigeria and Africa with requisite knowledge to thrive and prosper, the Entrepreneurship Centre of the Federal University of Technology, Minna (FUT Minna) in collaboration with the German Development Cooperation (GIZ), Lead Resources, Central Bank of Nigeria (CBN) & Sterling Bank Plc in 2020 initiated and developed the SME-Sabi App. The SME-Sabi App is a unique online digital application that enables emerging Small & Medium Scale Enterprises (SMEs) stand out in making smarter business decisions and choices through online entrepreneurial education aimed at improving SMEs operational capacity to do businesses gainfully, improve entrepreneurship and add entrepreneurial value.

The courses are free and can be studied at any time and pace. On completion of all online assessments successfully on the SME-Sabi App, a personalized certificate jointly endorsed by the Entrepreneurship Centre of Federal University of Technology, Minna (FUT Minna),

Central Bank of Nigeria (CBN) and the German Development Cooperation (GIZ) in Nigeria is issued, digitally to Entrepreneurs.

SME-Sabi App is a free digital and e-Learning platform that brings entrepreneurship and financial knowledge directly to Small & Medium Scale Enterprises (SMEs) in Nigeria, Africa and the World considering that Small & Medium Scale Enterprises (SMEs) are the key drivers of job creation and economic growth in any economy and nation.

Participation in SME-SabiCourse is done, firstly, through a seamless digital linkage via any smart device (Mobile Phones, Ipads & Laptops) to the SME-Sabi App on Google Play Store or navigating without glitch to the SME-Sabi website by imputing <http://www.smesabi.com/lms> on the web address bar of any smart device with access to the internet; afterwards, Registration is further done by simply clicking on the Register button on the SME-Sabi website and entering the participant's choice username and password in the form fields provided which pings to <http://www.smesabi.com/lms/login/index.php> as designed by SME-Sabi App Developers at FUTMINNA Entrepreneurship Centre. Next, follows the setting up of a new participant's user account through the completion of each form field with the participant's vital bio-data upon which a new user account is created on the SME-Sabi App interfacing to new user successful login which beams a course overview panel on the SME-Sabi App dashboard bearing the available course contents for participants to view, surf, interact & learn; thus, instantaneous learning on SME-SabiCourse(s) kick-starts which finishes as the participant and learner takes the last course and the accompanying online examination on the App after which digital certificate(s) is issued.

SME-Sabi App is streamlined into 4 online courses for easy assimilation vis-avis: Basic Financial Literacy Online Course which encapsulates basic introduction to Entrepreneurship within the Nigerian entrepreneurial landscape; after which, comes, Advanced Financial Literacy Online Course that delves deeper into the rudiments of Entrepreneurship through the deconstruction of Nigeria's regulatory and operating Ministries, Departments & Agencies overseeing administration and development of Entrepreneurship in the country while the third online course in this unique digital SME-Sabi App morphs learners from amateurs to professionals through tutelage on Financial Literacy Trainer Course which arbitrarily summarizes the preceding two courses and at the same time consolidates the learner's capacity for critical thought and transfer of knowledge gained to new entrants into the

Course. The last online course in the SME-Sabi App Online Course List is Entrepreneurship Fundamentals that stretches the imaginative capacity and creative potential of learner-entrepreneurs through the realms of entrepreneurial adventure and rejuvenation where they set new frontiers and strive to attain the seemingly impossible entrepreneurially.

2.0 Reviewing the Psychological & Thematic Motivation for Conceptualizing the SME-Sabi App

Alenoghena, C., *et al* (2020) in conceptualizing the SME-Sabi App during the App's developmental stage coined and settled for the usage of the word *SABI* from Nigerian Pidgin variant of Queen's English meaning '*to be able to do*' something, anything and in fact just everything. The term *Sabi* from the viewpoint of Nigerian Pidgin English speakers and online Encyclopedia, www.wikipedia.com, connotes a person's wide-ranging ability to do a(ny) job, task and assignment perfectly fervently with little or no blemish after the execution and completion of such a job, task and assignment.

In considering the psychological background and motivation that drove Alenoghena, C., *et al* (2020) to conceptualize and title the SME-Sabi App particularly with their coined word usage of *Sabi*, clearly shows their dexterity indisputably in not only developing a multidisciplinary, universalized and multipurpose Digital Application with the ability to solve human problems aboard several boundaries, disciplines and spheres but titling it too, to further reflect the underlying motive and psychology behind the App's birth and conceptualization (Amusa, T. L (2024)).

While Alenoghena, C. *et al* (2020) appears to have narrowed the scope of the SME-Sabi App to cover learning outcomes within ambits of entrepreneurial and business operations of Small & Medium Scale Enterprises (SMEs) in Nigeria and Africa in conformity with the core mandate behind establishing the Entrepreneurship Centre of the Federal University of Technology, Minna in Niger State, Nigeria; the SME-Sabi App from prospects of its far-reaching usefulness to the global SME Entrepreneurial network and wide-ranging applications to governmental and non-governmental organisations ecosystems currently overrides the founding motives of the App's developers in persons of Alenoghena, C. *et al* (2020) together with Entrepreneurship Centre of the Federal University of Technology, Minna, German Development Cooperation (GIZ), Lead Resources, Central Bank of Nigeria (CBN) & Sterling Bank Plc.

The following part of this Academic Paper appositely explores the role of the SME-Sabi App in catalysing, enhancing and facilitating a country's national economic development through simultaneous examination of its applications in selected key sub-sectors in the vein of Defence, Education, Health, Agriculture, Entertainment & Mobile Telecommunication, Trade, Investment & Commerce, Environment, Governance & Electioneering underscoring national development.

A thorough parametric evaluation of the SME-Sabi App catalysis of a nation's development can considerably reveals the extent of the App's indispensability to inter-governmental ecosystems comprising local, national, regional & international governing establishments owing to the widespread worth these governing establishments is, to individuals, entities, groups & institutions because of its centrality to the successive realization of any nation's economic yearnings together with her developmental goals & objectives.

3.0 Consideration of the immense Application of SME-Sabi-App to Key Sectors of Nigeria in Catalysis of National Economic Development

3.1 Defence: Digitally remodelling how Nigeria's cadet-scholars train & learn

In broadening the founding motive of designing and developing the SME-Sabi App by Alenoghena, C. *et al* in 2020 at the Entrepreneurship Centre of the Federal University of Technology, Minna (FUT Minna), an eco-critical consideration of the SME-Sabi App application to the Defence sector of Nigeria indicates that the App will be gainful in several Security Colleges and Defence Academies taking emphatic references to the Nigerian Defence Academy (NDA), Zaria, Kaduna State and Police Academy in Wudil, Kano State, Nigeria.

Tutors in these National Security Academies can employ a re-modelled version of the SME-Sabi App to arrange and prepare lecture notes and schedules digitally for cadet-students which shall see them learn at their own pace, space and time of convenience obliterating the necessitation of physical classroom attendances since the Defence Academies curricula are designed to also accommodate a martial and guerrilla training component; a re-modelled version of the SME-Sabi App in the Academies will facilitate the placement of regular cadet-scholars on basic martial training on normal day-class periods while lectures is re-routed

through the re-modelled version of the SME-Sabi App online for the cadet-scholars that can be done through nightly hours including tests, examinations and grading.

3.2 Education: Revolutionizing learning outcomes during academic staff union actions & strikes

On preliminary test and experimentation of the SME-Sabi App upon completion of its design and development; a trial version of the App through mass-emailing of its link was circulated to the whole undergraduate students of the Federal University of Technology, Minna through the University's dedicated bulk emailing system hosted by Tech-giant – Google during the prolonged industrial action and strike of Academic Staff Union of Universities (ASUU) at the wake of the Covid-19 Lockdown during first quarter of 2020, saw massive traffic from FUTMINNA Students engage the idle period on the SME-Sabi App learning Entrepreneurship. The simple realization from this feat is that the introduction of a re-modelled version of this SME-Sabi App to the Nigerian Educational System can bring about an unbelievable revolution when there's an industrial action or strike by Nigeria's Academic Unions and Congresses as lecturers can arrange lecture schedules that can be hosted for students while at home during strikes with tests and even exams taken prior to the call-off of such strikes.

3.3 Health: Rejuvenating primary healthcare service delivery for Nigeria's underprivileged and socially-excluded class

Considering the high level of sensitivity required for best healthcare practices and management especially at the primary healthcare service delivery levels, stakeholders within the primary healthcare sub-sector oftentimes grapples with undue challenges of professional medical input during emergency medical situations like maternal labour during child delivery, accident victims with bullet wounds and infants with burns and scalds; because often times, Nigeria's primary healthcare centres wouldn't have a well-trained medical expert (doctor) on ground to intervene quickly before a precious life is lost during emergency situations; this undesirable medical scenarios makes the introduction and domestication of a re-modelled version of the SME-Sabi App into Nigeria's primary healthcare sector grossly inevitable; why...?, because, a re-modelled version of the SME-Sabi App for the primary healthcare system will be designed and developed to link-up a(ny) primary healthcare attendant present in a primary healthcare centre during emergency situations to a well-trained

medical for practical-based and visualized methods on how to resolve medically-related challenges, thus, abating unwarranted deaths and therapeutic deteriorations of Nigeria's underprivileged and socially-excluded class at the primary healthcare management level.

3.4 Agriculture: Promoting smart all-inclusive agriculture to farmers in rural communities

Recent research findings of Madukwe, M.C. *et al* (2020) on Agricultural Extension Services clearly shows that the practice of Agricultural Extension in the country is retrogressing due to factors related but not limited generally to poor funding of Agricultural Extension by government at all levels (Federal, State & Local) in Nigeria; equally, challenge of distance, proximity and geographical coverage between professional agricultural extension workers and farmers farming in rural areas of Nigeria has considerably limited the flow of information on agricultural price listings, markets, weather forecasts, latest agricultural farm practices and current government interventions in agriculture which has an undesirable effect of retarding these rural farmers' agricultural productivity and outputs; an online digital platform like SME-Sabi App can be employed and modified to bridge this perpetuating farmer-extension-worker communication barriers by gainfully connecting both partners digitally where the Agricultural extension worker can digitally-visually demonstrate the current agricultural price listings of wide-ranging food products, markets for sale and distribution of produce, latest agricultural storage methodologies and the optimal agricultural farm practices covering farmers in rural communities which will eventually help Nigeria escape her current food shortages and crisis, food price inflation, thus, attain food sufficiency and agricultural sustainability in record time.

3.5 Entertainment & Mobile Telecommunication: Strengthening unity of Nigeria through learning

Earlier operations of the biggest 4 Mobile Telecommunication Companies in Nigeria, MTN, Globacom, 9Mobile & Airtel saw them provide basic telecommunication services to subscribers without any form of entertainments attached, however, progress in service offering by these Companies occasioned through advancement in telecommunications technology gradually embedded entertainments to the basic telecom services through the inclusion of Subscribers' Caller Tunes, Online Computer Games & Video calls. The SME-Sabi App can be altered to follow suit by singularizing the dual functionality of learning and

entertainment simultaneously by adding Nigeria's anthem, pledge and other landmark national cultural musical tones from King Sunny Ade to Onyeka Onwenu and Dan Maria on the SME-Sabi App savouring users through the wonderful rhythms of Nigeria's golden voices (years-ta-years) on the App's background during exploration by users. Equally, Nigeria's telecommunication operators, MTN, Globacom, 9Mobile & Airtel can be incorporated into this SME-Sabi App project through collaboration that can enable trans-app calls with textual chats on learning progress and tests outcomes with a potential of creating its own online community of ideation and information-sharing. The SME-Sabi App has enormous capacity of uniting Nigeria in similar vein like Football and other sister sporting activities.

3.6 Trade, Investment & Commerce: Eradicating youthful restiveness, mass poverty through entrepreneurial renewal and consciousness

A phenomenal breakthrough of this SME-Sabi App project as envisioned by the App's Developers, Alenoghena, C. *et al* (2020) on conceptualization is that it should eradicate youthful restiveness and mass poverty through entrepreneurial renewal and consciousness; considering the large swathe of students in Federal University of Technology, Minna (FUT Minna) and other Universities in the country that subscribed to the Entrepreneurship Course evidential from the heavy traffic flow to the SME-Sabi App recorded when the App was initially tested during wake of the Covid-19 Lockdown in early, 2020; we can considerably concur definitely that this SME-Sabi App greatly achieved the motive for its design and development. Feedbacks and testimonies (responses) from past user-entrepreneurs and respondents – when we administered questionnaires to ascertain respondents' satisfaction with their use of this unique online digital application, SME-Sabi App – returned responses showing that the App have positively impacted them with progress attestation hovering up to about 99% on percentage mean scores with a higher class of this respondents admitting to setting-up their own Small & Medium Scale Enterprises (SMEs) in Nigeria and recording huge profits year-in, year-out after surge of the national economy from the earlier plummeting by the Covid-19 Pandemic.

The considerably large extent to which SME-Sabi App eradicated youthful restiveness and mass poverty since its development and usage from 2020 shows the App's indispensability to

entrepreneurial renewal and consciousness as regards its catalysis to Nigeria's national economic growth and development.

3.7 Environment: making mother-earth Nigeria, safer home for everyone

Amongst numerous applicable areas of SME-Sabi App to Nigeria's national economic development on environment is the App's catalytic impact on environmental safety administration in governance, civil environmental action and activism. In contemporary Nigeria, challenge of crude-oil spillage from industrial crude-oil extraction in the South-southern Niger Delta region together with the exacerbating Deforestation in the upper Northern region of the country has continuously threaten the stability of the ecosystem. The result of these indiscriminate environmentally-unfriendly activities is gas-flares and carbon emissions that threaten human and environmental health occasioned with rapid negative ecological succession. To stem this undesirable tide amidst rising global climate change advocacy is the need to conceptualize an approach that is not only cost-effective but far-reaching, thus, the crucial need to adopt SME-Sabi App in addressing emergent environmental-related challenges. Conversely, SME-Sabi App can be streamlined for use in Nigeria's environmental protection advocacy and policy formulation particularly in those areas (Niger Delta & Upper Northern Nigeria) that it impacts the most by embedding modules of environment safety guidelines and action plans digitally accessible 24/7 online for stakeholders, policy formulators and the government in bid to meet Nigeria's set developmental goals and objectives in the environmental sub-sector.

3.8 Governance & Electioneering: Synchronizing political leadership gains to yearnings of Electorates

Since the advent of the 4th Republic in Nigeria's current political dispensation, selection of political office holders through balloting – electioneering – in the country has not been without some peculiar challenges notable of which encompasses low voter education owing to large numbers of voters in the country occasioned from high incidence of formal and digital voter illiteracy which precursors pre-&-post election related violence and vice amidst looming voter intimidation and inducements.

The alteration of the operational functionality of SME-Sabi App to suite and serve the electioneering process of specific and general elections administered by Nigeria's electoral

umpire, Independent National Electoral Commission (INEC) in the area of voter mobilization and education, dissemination of election timetables and guidelines for participating political parties will drastically reduce and possibly eradicate illiteracy-related election qualms, electoral malpractices, violence, inducement and intimidation by either or all active election voters, political parties and their agents together with civil society organizations. The SME-Sabi App stands at a greater vantage point of not only preventing election-related malfeasances but further avoiding needless post-election litigations at election petition tribunals and courts by political aspirants, parties, agents and associated proxies in a vein that synchronizes political leadership gains to the electoral yearnings and aspiration of Nigerians.

4.0 Prospects of SME-Sabi App in synchronizing Inter-Governmental Ecosystems at Local, National, Regional & International Levels

Considering that the organization of government and governance at either or all of Local, National, Regional & International levels is continuous and requires periodic collaboration, the SME-Sabi App will go a long way in facilitating this collaboration amongst the various tiers of government, Judicial, Legislative & Executive through the creation of a digital node for inter-governmental peer review mechanism that measures how their performance(s) in terms of service delivery impacts the Nigeria polity and people and further equate if the resources (monetary or otherwise) voted and utilized by the government on any tier and organ justifies the anticipated value-addition on either capital and recurrent capacity. SME-Sabi App can facilitate the synchrony and unification of inter-governmental ecosystems if modified to serve purpose of digital repository where processed data can be stored and retrieved for current or future usage. In view of the fact that national policy formulation, economic planning and programs conceptualization relies heavily on available data and existent information.

SME-Sabi App surely, can deliver beyond expectations and perform the unthinkable miracles of this current century and present decade.

5.0 Recommendations for future research & development of online digital applications

In spite of the possible contributions of SME-Sabi App to some selected key sectors underscoring and catalysing Nigeria's national economic development, it is highly

recommended that further researches on the SME-Sabi App be initiated by new researchers because it can unveil certain unseen and untapped potential of the App beyond what the initiators, Alenoghena, C. *et al*, and sponsors, Entrepreneurship Centre of the Federal University of Technology, Minna (FUT Minna), German Development Cooperation (GIZ), Lead Resources, Central Bank of Nigeria (CBN) & Sterling Bank Plc have been able to unveil so far.

It's for this reason that we call on research institutions, organized private sector players, civil society organizations and government at all levels to support and fund further research not just on the SME-Sabi App but on any other multi-purpose online digital application with enormous capacity of solving human problems in Nigeria, Africa and the entire world.

6.0 Conclusion

Preceding narratives in this academic paper, so far, has, to a considerable large extent, unequivocally established the viability of the SME-Sabi App as catalyst for national economic growth & development as any possible contrary arguments to this testament leaves the door open for future researchers to do justice and rationalize the submissions of Alenoghena, C. & Amusa, T. L., that co-authored the paper.

The paper's lead-author, Alenoghena, C., shores up the 'magic' of digitalization through the conceptualization of an online digital application in the vein of SME-Sabi App into the existing theories of how national economic growth & development can be catalysed as against the previous misconceptions of the catalysis being solely a function of trade and commercial activities.

The paper's co-author, Amusa, T. L., further corroborates Alenoghena, C.'s intellectual stance on the subject matter - SME-Sabi App: A Catalyst to National Economic Development through a scholarly collaboration that birthed this wonderful academic paper on firm conviction of it reaching the intended audience and impacting Nigeria, Africa and the general global society positively boundlessly.

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**FINANCIAL RESOURCE MOBILISATION STRATEGY AND SUSTAINABILITY
OF PRIVATE TERTIARY INSTITUTIONS: CONCEPTUAL REVIEW****Aliyu Musa Pandogari¹, Abdulwaheed Dauda (Phd)² Chetubo Kuta Dauda (Phd)³****Department of Entrepreneurship and Business Studies****Federal University of Technology, Minna****Corresponding Author: aliyumusapandogari@gmail.com****ABSTRACT**

Private tertiary institutions have to develop various strategies to mobilize resources to mitigate against the difficulties arising from the pressing need for the institutions to cover part of their costs. With private tertiary institutions playing increasingly vital role in meeting the demand for specialized skill and knowledge. Hence, this study aims to explore the effect of financial resource mobilization strategies on the sustainability of private tertiary institutions amid evolving global educational landscape. This study aims to review the dimension of financial resource mobilization strategies and their effect on the sustainability on private tertiary institutions. The dimensions of financial resource mobilization strategies in the current study include: fee revenue strategy, donor funding strategy, consultancy fee strategy and investment income strategy. This study offers insights to inform policy decisions and strategic planning for private tertiary institutions seeking to thrive in an increasingly competitive and dynamic educational landscape.

Keywords: Strategies, mobilization, resource, institutions

Introduction

The sustainability of private tertiary institutions is a multifaceted concept that requires a comprehensive approach. By addressing financial, operational, environmental, and social dimensions, these institutions can enhance their long-term viability and fulfill their important role in promoting sustainable development within their communities and beyond. Continued research and institutional efforts are essential to overcome the challenges and capitalize on the opportunities for sustainable private tertiary education.

Private tertiary institutions have played a significant role in expanding access to higher education globally (Supriyatin, 2023; Sofyan, 2021). However, these institutions have faced numerous challenges in maintaining their financial and operational sustainability. The decrease in government funding for higher education and declining enrollment have been major contributors to the financial difficulties experienced by private tertiary institutions (Francis and William, 2020).

To address these sustainability challenges, researchers have emphasized the importance of income diversification and the exploration of alternative revenue sources for private tertiary institutions. The institutional profile, such as denominational or non-denominational status,

has also been identified as a factor that can influence the financial sustainability of these institutions (Francis and William, 2020).

Financial sustainability remains a key focal point in empirical studies outlining the significance of organizational performance from the financial perspective. Progressively, a wide range of conceptualizations have been presented with regard to the idea of financial sustainability with some researchers taking note that this has to do with a situation where the financial system is functioning properly (Aghaie, *et al.*, 2021). Rasooliet *al.*, (2021) hold a view that financial sustainability has to do with situations where financial crises or external shocks do not affect the core functioning of a financial system in an organization.

Financial sustainability has a lot to do with how well an organization performs its value adding activities in order to generate enough resources from its clients so as to remain in operation into the foreseeable future. Corporate objectives of stakeholder welfare maximisation and corporate wealth maximisation can only be achieved in the long run if the organizations are financially sustainable. In a nutshell, financial sustainability is the ability to maintain or improve financial viability over time to assure continued and long-term achievement of mission, goals and objectives of an organization (Barrow and Rouse, 2016). Institutions of higher learning are expected to offer higher education that would support the socio-economic development of a nation. Therefore, to remain relevant in this role both in the short run and the long run, they should be financially sustainable.

Provision of qualitative and quantitative education involves mobilization and consumption of resources. The act of resource mobilization can be seen as a concerted effort to generate resources for a specified entity to fulfill a planned purpose. Such resources include, finance, human, material, machines, time, and nature itself (Chumba, 2023). Financial capital is a significant resource often assumed to be a part of physical capital. It is actually the basis for procurement, utilization, and maintenance of all types of resources. Without a strong financial base, it will be difficult to produce the right types of goods and services in desirable quantity and quality. Since the human economy is monetary, the availability of funds in any organization or institution is vital to its productive process and quality of its products and services. Specifically, resources are mobilized to achieve sustainability, non-dependency on single sources of funding, supplementary sources to existing funding, support to institutional overheads, alternative resources for new projects and to build reserve within the organization

to allow for long-term investments such as infrastructure equipment or purchase of land (Omukobaet *et al.*, 2011).

Efforts aimed at realizing financial sustainability have invariably been preceded by financial resource mobilization strategies. The idea of resource mobilization has to do with the amount of effort undertaken to activate network ties in the quest to realize the resource mobilization benefits in an organizational context (Thornton *et al.*, 2019). Nabulime (2021) defined resource mobilization as the process used in assembling resources as well as activities which are involved in securing new and additional resources in an organization. This definition concurs with that by Michael *et al.*, (2021) who looked at resource mobilization as a set of activities executed in securing new and additional resources for an organization. Additionally, resource mobilization has to do with the steps undertaken with the aim of collecting additional funds to finance development activities (Mohsin, 2022). Based on the foregoing definitions, it can therefore be synthesized that financial resource mobilization has to do with concerted efforts made by organizations towards achieving financial sustainability by putting in place mechanisms aimed at improving their financial status. Accordingly, these and other similar studies offer important insights with regard to what factors need to be considered for an organization to realize successful mobilization of financial resources. For instance, the need to tap into the existing human and material resources is an important pathway towards realising prudent use of financial resources within organizations.

Institutions of higher learning can utilize various financial mobilization strategies in the quest to realize financial sustainability. Bondzi–Simpson and Agomor (2021) while reflecting on the financing of public Universities in Ghana underscored the significance of adopting entrepreneurial approaches through the commercialization of academic services to generate resources for sustainable funding. Lutempo (2022) makes a case for the need for institutions of higher learning to come up with innovative strategies to bridge the funding gap due to reducing government support and improve financial sustainability in institutions of higher learning.

Private tertiary institutions in Niger State face challenges, including funding constraints, quality assurance concerns, inadequate infrastructures, and issues with accreditation. Financial Sustainability is a major hurdle due to over reliance on tuition fees, while maintaining quality education remains a priority amidst these challenges.

Conceptual Review

Concept of resource

Resource refer to tangible or intangible assets that an organisation owns, controls, or has access to on a semi-permanent basis. It is any physical or non-physical entity of limited availability that needs to be utilized to obtain a benefit ((Nwachukwu and Chladkova, 2019; Khieng and Dahles, 2015). Literature has recognised different types of resources, including technological, financial, human, physical, and material (Tortorella and Fogliatto, 2014). Material resources are any useful available material within an organisation, or within the organisation's environment (Koech, 2017). This may include; raw materials, machines and equipment (Batti, 2014). Human resources is used to describe both the people who work for an organisation and the department responsible for managing resources related to employees (Mitchell, 2014; Tortorella and Fogliatto, 2014). Finance is one type of resources that is very important in any organization (Wanjiku, 2016).

Financial resource

Financial resource is the monetary resource which serves as a means of acquiring all the other educational resources. Its availability and mobilisation is of great importance to any education industry (Onyekanet *et al.*, 2015).

Financial resources are part of the assets (property) of the organization, a term covering all financial funds of the organization (Monteiro *et al.*, 2017). They are the key resources that all private tertiary institutions need to be able to function and carry out their work (Batti, 2014). Depending on the source, financial resources may be targeted to specific expenses or be used at the institutions discretion (Othman and Ameer, 2014). Financial resources can be raised from individuals, corporations, government, or other in a variety of forms and through many means (Nwachukwu and Chladkova, 2019). Access to financial resources enables organisations to achieve sustainable growth, performance and as well as develop innovative initiatives (Khieng and Dahles, 2015). It becomes necessary for private tertiary institutions to mobilize for funds to achieve their ultimate mission (Liao *et al.*, 2015). Danso and Adomako (2014) noted that financial resource is important for the operations of firms. This study is focused on financial resources due to its relative importance to private tertiary institutions sustainability.

Concept of resource mobilization

In the contemporary world, private tertiary institutions across the globe are increasingly facing dwindling revenue and are therefore under pressure to look for other ways of ensuring that they remain financially sustainable. At the same time, private tertiary institutions are expected to be financially sustainable from their operations and therefore must look for other means of raising revenues besides their usual means.

Resource mobilization refers to the process used in assembling resources as well as activities which are involved in securing new and additional resources in an organization (Nabulime, 2021). Mwamba (2021) looked at resource mobilization as a set of activities executed in securing new and additional resources for an organization. Additionally, resource mobilization has to do with the steps undertaken with the aim of collecting additional funds to finance development activities (Mohsin, 2022). The idea of resource mobilization has to do with the amount of effort undertaken to activate network ties in the quest to realize the resource mobilization benefits in an organizational context (Thornton *et al.*, 2019). Resource mobilisation is the process by which financial resources are solicited. It is the continuous process of identifying and using a wide range of available resources to address identified financial challenges. It involves action-oriented resource gathering that provides a means to address a particular problem or a series of challenges (Kisigeet *al.*, 2017). A resource mobilisation strategy comprises a mix of mechanisms an institution employs to ensure the delivery of services in an efficient, equitable, and sustainable manner that will improve the quality of the education system (Kamanziet *al.*, 2018).

In view of the above definitions, it can therefore be said that financial resource mobilization has to do with concerted efforts made by private tertiary institutions towards achieving financial sustainability by putting in place mechanisms aimed at improving their financial status.

Financial resource mobilization strategies

Financial resource mobilization strategy involves plans and actions taken by individuals, organisations or institutions to gather, generate and manage financial resources effectively (Koech, 2017). It is a structured approach designed to secure funding from various sources and optimize the utilization of these funds to achieve specific goals (Chumba, 2023). Creating a financial resource mobilization strategy involves identifying potential fund sources, establishing clear goals, diversifying income streams, engaging with donors and

investors and utilizing various fundraising methods like grants, partnerships, crowd funding, or sponsorship (Ali and Kilika, 2016).

Financial resource mobilizing strategy of private tertiary institutions has to do with the activity of raising money for efficient and effective operation of institutions. The concept pertains to all activities involved in securing new and additional resources for the smooth running of the private tertiary institutions (Moshin, 2022). Financial resource mobilization has to do with concerted efforts made by organizations towards achieving financial sustainability by putting in place mechanisms aimed at improving their financial status (Rubarema, 2021). Mobilisation of financial resources basically implies being aware of the different types of resources that could be tapped to generate funds for the school and then endeavoring to actually augment the resources of the school. The school on its own can generate funds (Lutempo, 2020).

Fees revenue mobilization

Private tertiary institutions charge fees for the services they offer including teaching, research and community outreach. Rationally, it is expected that the fees charged to students and other service beneficiaries should be commensurate with the cost of the services. Evidence has proved to be otherwise Robinson and Sensoy (2013), for instance, stated that higher education institutions are presently charging higher fees as compared to the last few decades in an effort to sustain their study programmes. Nikiet *a.* (2017) refers to fees revenue mobilization as the systematic approach used by institutions to effectively generate income through fees charged for services offered. This can encompass various techniques such as optimizing fee structures, introducing new services with associated fees or adjusting existing fees to align with market demands and competitive landscape (Dumestre, 2016).

Donor funding mobilization strategy

Donor Funding Mobilisation Strategy involves the systematic approach used by organisations or initiatives to secure financial support from donors. This strategy aims to attract funding to sustain or expand programs, projects, or initiatives aligned with donors' interest and the organization's mission (Kobugabe, 2022). According to Chumba (2023), interest in the financial well-being of institutions higher education, whether public or private, for-profit or not-for-profit such as: regulatory agencies, licensing officials, accreditation agencies, equity owners whether present or potential in the case of for-profit institutions funding, and other financial resource providers (e.g. donors) and recipients of institutions' service, the

governance of projects has suffered sustainability due to poor community participation, low educational levels among households, undiversified households and poor understanding of governance. The loss of government resources to core activities has meant that private institutions of higher learning have increasingly turned to donor funding as a major source of obtaining financial resources to run core activities including institutions infrastructure, teaching and the development of academic and nonacademic staff (Osei-Kuffouret *al.*, 2020; Almagtomeaet *al.*, 2019). Private tertiary institution need to develop strategies that align with the objectives of the donor, i.e private individuals, institutions and agencies, in order to benefit from the targeted donor funds. Private institutions of higher learning have to develop sustainable donorfunding strategies that are broad enough to provide adequate resources without compromising on the core agenda of the institutions– teaching, research focus, innovation and community outreach. This calls for a trade-off that balances out the donor funds revenue with the need to sustain the university operations without compromising on the core agenda of the institutions.

Investment income mobilisation strategy

A funding mobilization strategy which is increasingly becoming an alternative to traditional sources of private institutions of higher learning support involves various forms of commercial activity or income generation or earned-income activities as termed by some studies (Murage and Onyuma, 2015). Investment Income Mobilisation Strategy involves methods used by institutions, businesses or organisations to generate returns and maximize income from their invested asset (Ahmad, 2019: Alonso-Cañadas *et al.*, 2017). Investment income is likely to provide tremendous supplementary income to support the activities of private institutions. They are able to engage in investments given the academic cycles and that there are periods of time when they can access huge amounts from financial resources especially at the onset of academic calendars when large amounts of fees are paid. It is from these sums that a variety of investments can be made in financial and real assets to help generate interest, dividends, royalties, rent and similar associated incomes (Vaceková and Svidroňová ,2014). This is a critical strategy given that financial markets are increasingly vibrant and provide a wide variety of funding opportunities. Optimal investment implies that the universities must adequately evaluate the available risks and returns before investing university resources into income generating activities that may assure such income as rent, royalties, dividends, interest, lease income and such like. If not well evaluated, investment

income may dwarf investment costs and thereby cost the university the hard-earned resources (Chumba, 2023).

Consultancy resource mobilization strategy

Mobilizing financial resources through consultancy can be a valuable revenue stream and a means to leverage expertise. Consultancy revenue refers to the income generated by institutions through the provision of advisory, expertise, or specialized services to clients. Consultancy refers to the provision of expert knowledge to a third party for a fee (Vasi and King, 2012). This revenue primarily comes from fees charged for consultancy's expertise, knowledge and guidance provided to businesses, organisations or individuals seeking advice, solutions or improvement in various ways.

Consultancy strategy can serve as a critical avenue for revenue mobilization given the high level of expertise available in higher institutions of learning and serve as a way of bridging the gap between private tertiary institutions and industry practice. Consultancy is critical and if properly and professionally handled, it can create a number of new commercially viable opportunities. Akinyemi (2013) opined that consultancy strategy is instrumental in assisting to update the skills of the academic staff and bridging the gap between research output and applied research problems.

Financial sustainability

The financial sustainability of private tertiary institutions is a topical issue among researchers and policymakers (Nalwoga, 2021). Private tertiary institutions are an essential component of many countries' higher education systems (Alonso-Cañadas *et al.*, 2017). Private universities contribute significantly to achieving global and national strategic educational goals. However, these international and national goals cannot be achieved without having financially sustainable Universities (Nalwoga, 2021). Financial sustainability is an entity's ability to operate with reliable net income and a growing net asset base, prudently balancing assets with liabilities (Nalwoga, 2021). Akeelet *et al.*, (2019) define financial sustainability as a firm's capacity to meet its short-term and long-term financial obligations while providing the appropriate quality of service delivery. In a similar vein, financial sustainability is a firm's ability to smoothly run the operations with maximum profitability while at the same time having enough liquidity to face the challenges of bankruptcy (Njiku and Nyamsogoro, 2019). Mandanici and Pace (2016) indicated that financial sustainability relates to the interaction

between three principal factors. These are identified as leverage, financial autonomy and liquidity.

Financial sustainability is considered as an integral part of organizational strategy to sustain its financing for a longer time. Kharlamoua and Sazonou (2014) noted that financial sustainability is an ideal measure of the financial status of a institutions. To achieve financial sustainability, private tertiary institutions must adopt optimal financial resource mobilisation strategies with lower risks and avoid relying on one approach or source of income that results in more significant financial distress (Grujić, 2016).

Conclusion:

In the evolving landscape of higher education in Niger State, the financial resource mobilisation strategy is critical for the sustainability of private tertiary institutions. This conceptual review has highlighted the multifaceted nature of financial sustainability, emphasizing the importance of diversified income streams, effective governance, strategic partnerships, and innovative funding mechanisms. Private tertiary institutions must navigate a complex environment marked by limited government support, increasing operational costs, and competitive pressures. Therefore, the adoption of a robust financial mobilisation strategy is paramount. This involves leveraging tuition fees, philanthropic donations, grants, endowments, and income-generating ventures. Additionally, fostering alumni networks and engaging in public-private partnerships can provide substantial financial support. Effective financial management and strategic planning are essential to ensuring these institutions can not only survive but thrive in the long term. This includes prudent budgeting, transparent financial reporting, and continuous assessment of financial strategies to adapt to changing circumstances. The sustainability of private tertiary institutions in Niger State will depend largely on their ability to innovate and adapt. By implementing comprehensive and dynamic financial mobilisation strategies, these institutions can secure the necessary resources to enhance educational quality, expand access to education, and contribute to the socio-economic development of the region. In conclusion, the sustainability of private tertiary institutions in Niger State hinges on strategic financial resource mobilisation. A well-rounded approach that incorporates diverse funding sources, sound financial management, and innovative practices will enable these institutions to achieve long-term viability and continue to fulfill their educational missions.

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**ASSESSMENT OF THE LOGISTICS OF SCHOOL FEEDING PROGRAMME IN
CHANCHAGA LOCAL GOVERNMENT AREA, NIGER STATE, NIGERIA.**

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ABSTRACT

The importance of logistics to the successful implementation of school feeding programme (SFP) cannot be overemphasised. It is on this premise that the study assessed the logistics involved in providing meals to students within the public primary schools in Chanchaga Local Government Area (LGA) of Niger State. The study covered activities such as sourcing of food, transportation, storage and distribution. Questionnaire and direct observation were used for data collection. Descriptive analytical method were used to analyse derived data. Findings revealed that crop grown by the network of local farmers within the State were the sources of food for the SFP. The food are locally sourced from all the 25 LGA in Niger State. Out of the 25 LGA in the State, rice is being sourced from 8 LGA which represents 32% while soya beans is being sourced from 5 LGA which represents 20% of the location where food is being sourced. Trucks were used by Local Farmers to transport raw food to Chanchaga LG Secretariat (distribution centre). Maikunkele being the proximate settlement to distribution centre, covers an estimated distance of 10km while Edati LGA being the farthest distance covers an average distance of 121km to the food distribution centre. The women (540) recruited as cooks (vendors) for the SFP were recruited from various communities where the benefiting public primary schools are located. Raw food are collected at the distribution centre by the cooks, transformed into cooked food in their individual homes and packaged in coolers for the feeding of the pupils based on the State Government approved feeding menu. The cooks live near the schools, hence, do not need to cover long distances in order to convey the food to the schools. Among the nine major constraints identified, corruption ($M=4.39$) and poor remuneration of cooks ($M=4.25$) were ranked highest while the least of the challenges to effective implementation of SFP in the State is political interference ($M=3.21$). The study recommends amongst others, that the State Government should provide better storage facilities to prevent spoilage and wastages of farm produces supplied by farmers within the locality.

Keywords: Logistics, Food, School-feeding, Public Primary School, Chanchaga

Introduction

Examining the logistics of school feeding initiatives within Chanchaga Local Government Area of Niger State is a critical undertaking aimed at gauging the efficacy and efficiency of these programs in addressing nutritional requirements and educational outcomes. Such feeding schemes have emerged as pivotal interventions in the fight against malnutrition and the enhancement of school attendance and academic performance, particularly in economically disadvantaged regions like Chanchaga. However, the triumph of these initiatives heavily hinges on the seamless execution of logistical tasks encompassing procurement, transportation, storage, and distribution of food commodities to educational

institutions (Adebisi *et al.*, 2020). Given the intricate nature of logistics management within the sphere of school feeding programs, a thorough evaluation becomes imperative to pinpoint challenges, identify lacunae, and unearth avenues for enhancement, thereby ensuring the uninterrupted provision of nourishing meals to schoolchildren.

In the specific context of Chanchaga Local Government Area, grasping the intricacies of school feeding logistics holds utmost significance due to the socio-economic dynamics prevailing in the region and the alarming prevalence of malnutrition among school-aged youths. Efficient management of logistics stands as a linchpin in guaranteeing the prompt dispatch of food provisions to schools, upholding standards of food quality and safety, and curtailing wastage (Makindeet *al.*, 2019). Moreover, logistical impediments such as subpar road networks, inadequate storage facilities, and a dearth of transportation resources pose substantial hurdles to the seamless execution of school feeding endeavours. Hence, conducting a comprehensive assessment of logistics within Chanchaga becomes indispensable for policymakers, stakeholders, and implementing bodies to craft strategies that optimize resource allocation, streamline operations, and ultimately amplify the efficacy of school feeding initiatives in bolstering child well-being and educational attainment.

2. Literature Review

The School Feeding Program (SFP) stands as a pivotal mechanism worldwide, facilitating children's access to education while providing notable benefits to underprivileged youths in terms of physical growth and cognitive development (Mastewalet *al.*, 2018). Recognized as a well-established developmental aid endeavour, SFPs aim to combat hunger, malnutrition, and educational deficiencies by offering daily meals to students (Andreas *et al.*, 2014). The logistical dimension of school feeding encompasses overseeing the supply chain to ensure the efficient distribution of food to educational institutions (Andreas *et al.*, 2014). This involves various tasks such as locally sourcing food, procuring from nearby producers, and coordinating delivery to schools (Mahadevanet *al.*, 2013). The ultimate goal is to provide meals to attending students, either consumed on-site or taken home as provisions (Joãoet *al.*, 2019).

Strategies such as grouping schools, assigning suitable distribution vehicles, and optimizing vehicle routes within clusters aim to enhance efficiency, as suggested by Constance *et al.*

(2020). The overarching aim is to ensure timely food delivery to schools, thereby maximizing the effectiveness of school feeding programs. Through adept management of the supply chain, these programs can contribute significantly to improving educational outcomes, food security, and developmental goals. In the theoretical realm, various concepts and practices come into play, shaping the management and efficacy of local food supply chains within school feeding programs. Supply Chain Management Theory underscores the importance of coordinating and integrating activities to ensure resource and product flow efficiency. Within local food supply chains, factors such as infrastructure development and the adoption of blockchain technology are deemed critical for mitigating food losses and enhancing transparency (Claudia *et al.*, 2022; Tim *et al.*, 2019).

Additionally, leveraging dynamic capabilities like supply chain orientation and innovation practices can foster sustainable management practices (Nida *et al.*, 2022). Lean Management Theory, on the other hand, focuses on optimizing efficiency and minimizing waste through principles such as low inventories and streamlined operations, particularly advantageous within the food commodity supply chain (Eliseo *et al.*, 2018; Chutchai *et al.*, 2011). Just in Time Theory and Risk Management Theory emphasize strategies for efficient procurement and risk mitigation, respectively, while Sustainability Theory highlights the importance of environmentally conscious solutions and community engagement (Per *et al.*, 2016; Andreas *et al.*, 2014; Elena and Pagliarino, 2015). These theoretical frameworks provide valuable insights into enhancing the logistics of food supply within school feeding programs, ultimately promoting healthy eating habits and nutrition among students while ensuring sustainability and efficiency in operations.

3.0 Study Area and Methodology

3.1 Study Area

Minna, the Capital of Niger State, is located at 9.62 latitude and 6.55 longitudes with 243m elevation above the sea level (World Atlas, 2019). Minna shares boundary with Shiroro Northwards, Paikoro Eastwards, Katcha Southwards and Wushishi in a Westerly direction. Minna is divided into two Local Government Areas namely Bosso LGA and Chanchaga LGA. Figure 1 shows Map of Nigeria indicating the location of Niger State while Figure 2 shows the map of Niger State indicating the precise location of Chanchaga LGA. Whereas Figure 3 is showing Map of Chanchaga LGA which is the study area where the school

feeding programme is implemented. The estimated projected population of Chanchaga LGA in Niger State at 2023 was 362,795 (NPC, 2006). Chanchaga LGA has a total of 36 public primary schools benefitting from the National school feeding programme. The thirty six (36) schools are distributed across eleven (11) geo-political wards in the Local Government Area.

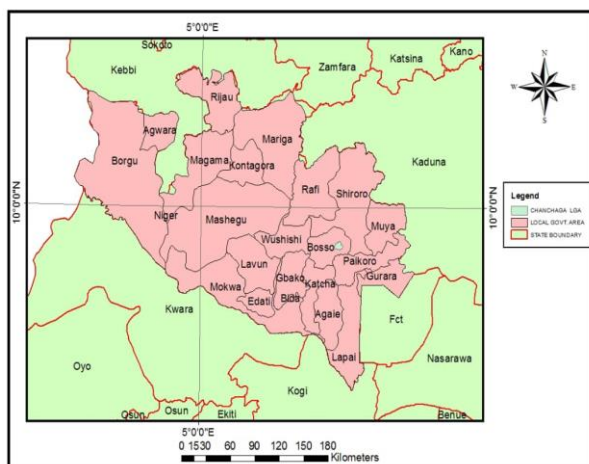
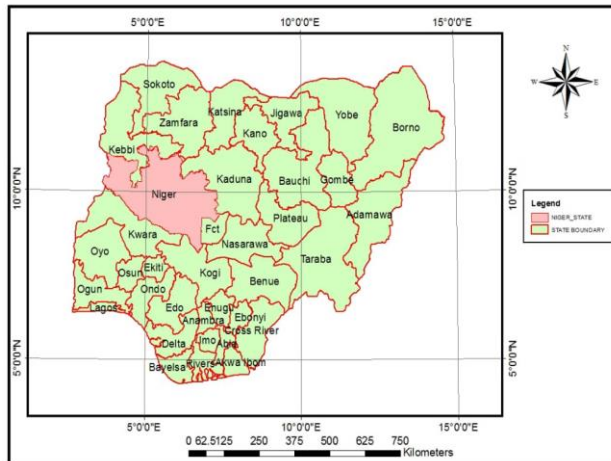


Figure 1: Nigeria Map indicating Niger State
LGA

Source: Grid3 Nigeria, 2023

Figure 2: Niger State Map showing Chanchaga

Source: Grid3 Nigeria, 2023

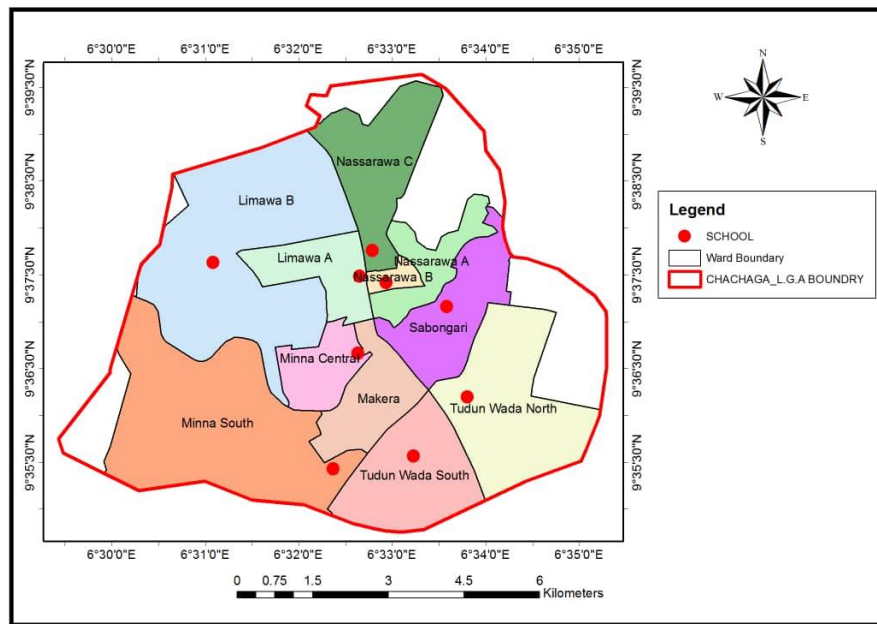


Figure 3: Ward map indicating geographical location of selected schools

Source: Author's Digitized Work from Grid3 Nigeria, 2023

3.2 Methodology

A descriptive survey research design was adopted to examine the logistics of school feeding programme in Chanchaga LGA. Data types adopted for this study were derived from primary and secondary sources. The primary data were acquired through the use of questionnaires, global positioning system (GPS), camera and direct observations while secondary data were acquired from Grid3 Nigeria and National Population Commission (NPC, 2006 census). The questionnaires were administered to staff at Chanchaga Local Government Secretariat and National Social Investment Programme, Niger State to collect first-hand information pertaining to food sourcing, transportation, storage and distribution to the public primary schools. The GPS was used to acquire the geographical coordinates of the selected schools in the LGA, in order to aid in the spatial description of the benefitting schools across the LGA. On-site photographs were taken from the schools during meal distribution and pictures of the farm produce taken to the LG Secretariat (distribution centre) were also captured using digital camera.

4.0 Results and Discussion

4.1 Food Sourcing for School Feeding Programme

Figure 4. Shows the locations where rice, one of the major food in the menu for school feeding programme is procured. According to the State Programme Manager of the National Home Grown School Feeding Programme, Niger State, rice is locally sourced from Wushishi, Agaie, Edati, Gbako, Katcha, Lapai, Lavun and Gurara Local Government Areas. From Figure 4, rice for SFP is sourced from eight (8) LGA which represents 32% of the entire Local Government Areas where food for SFP are being sourced.

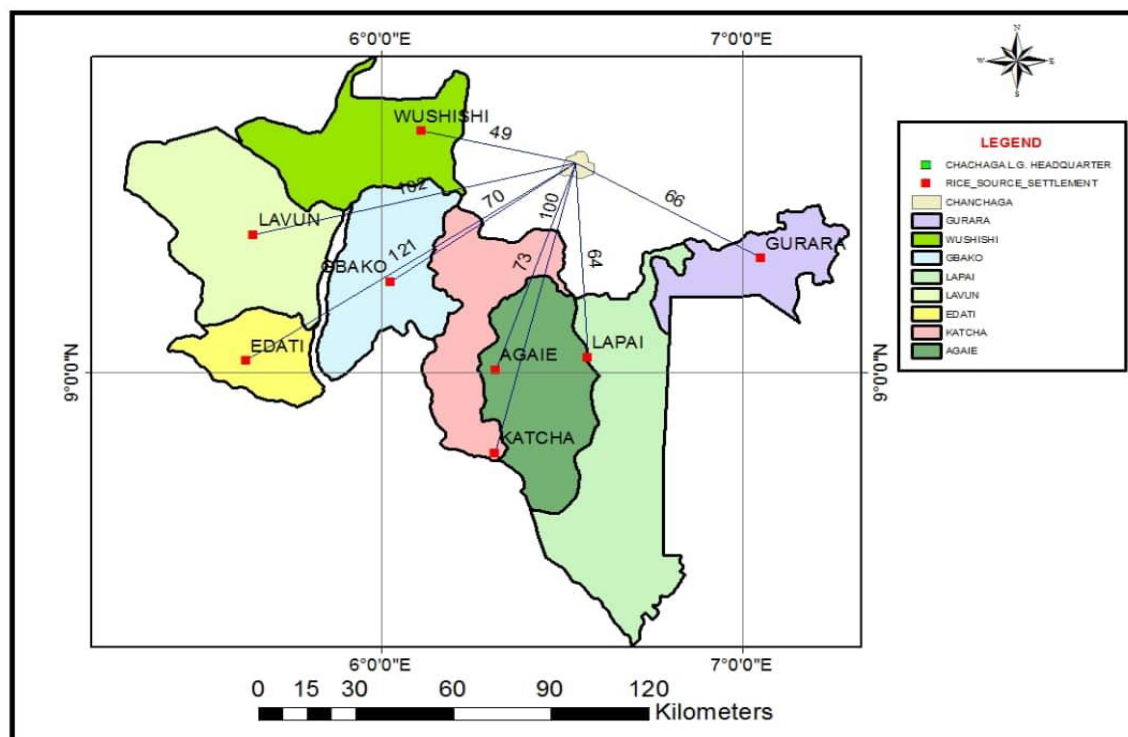


Figure 4: A contexture map of locations where rice grains are sourced

Source: Author's Digitized Work, 2023.

In relation to the distance covered from the study area, Figure 4 also shows that the estimated shortest average distance covered while transporting rice from the various locations is 49km (Wushishi LGA) while the estimated longest average distance covered is 121km (Edati LGA). Rice suppliers from Lapai (64km) and Gurara (66km) travel nearly the same estimated distance to the study area to supply rice while those from Gbako and Agaie travel 70km and 73km to supply their rice. Likewise, suppliers from Katcha and Lavun cover an estimated

average distance of 100km and 102km to the study area. The foregoing analysis shows that the socioeconomic effects of the SFP goes beyond the immediate location of the schools, but also contribute to the inter-community interaction of the communities.

In the same vein, as shown in Figure 5, yam tubers distributed for the feeding programme are locally sourced from Sarkin Pawa, Kuta, Gwada, Fuka, Dandaudu, Beni, KafinKoro, Lambata, Paiko, Maikunkele and Garatu areas in Niger East Senatorial District of the State. All these aforementioned settlements create 6 LGA which represents 24% of the entire 25 LGA in the State.

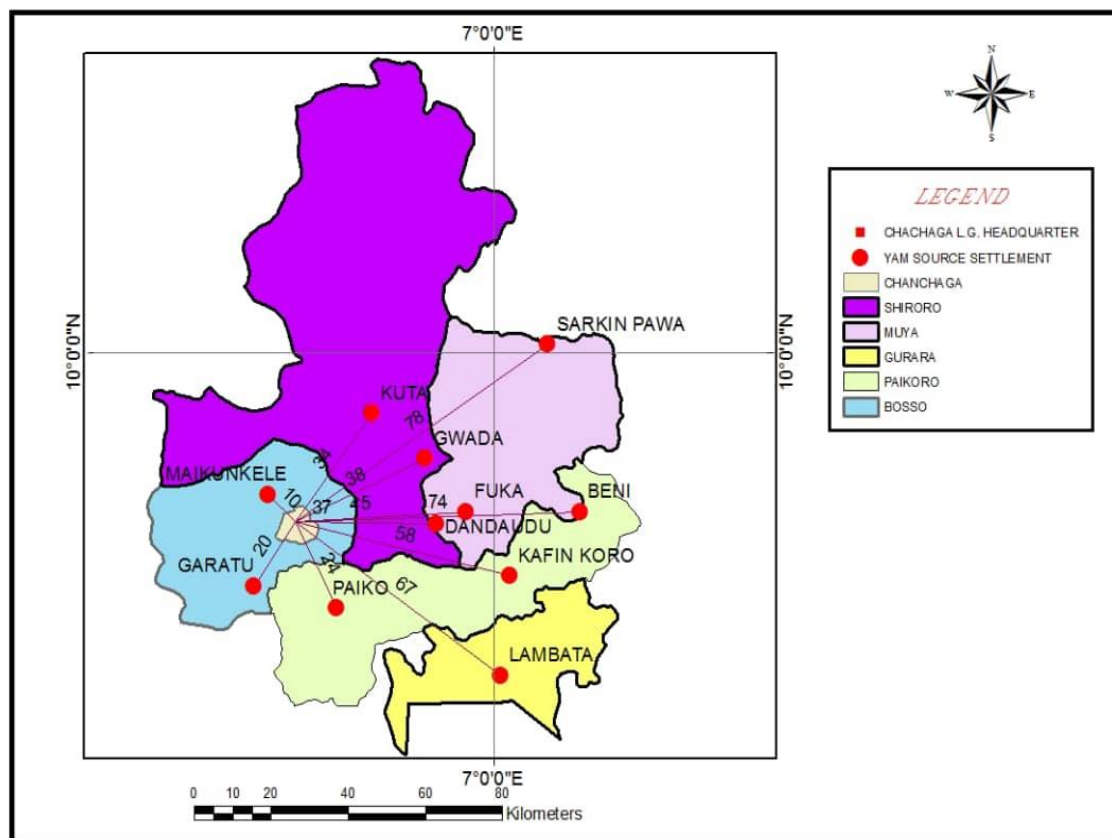


Figure 5: A contexture map of locations where yam tubers are sourced

Source: Author's Digitized Work, 2023.

Again, Figure 5 shows the distance covered from the distribution centre to the various locations where these yam tubers are sourced for the school feeding programme. From the map, Maikunkele is the nearest settlement with estimated distance of 10km from the study area while Sarkin Pawa settlement in Munya Local Government Area is an average of 78km

from the study area, making it the farthest estimated distance covered. Garartu and Paiko settlements cover almost the same distance (20km and 24km) from the study area while the estimated distance covered transporting yam tubers from Kuta, Dandaudu and Gwada is 34km, 37km and 38km respectively. Also, Fuka, KafinKoro and Lambata settlements are settlements where yam tubers are sourced in large quantity for the purpose of school feeding programme and these settlements cover estimated distance of 45km, 58km and 67km respectively from the distribution centre.

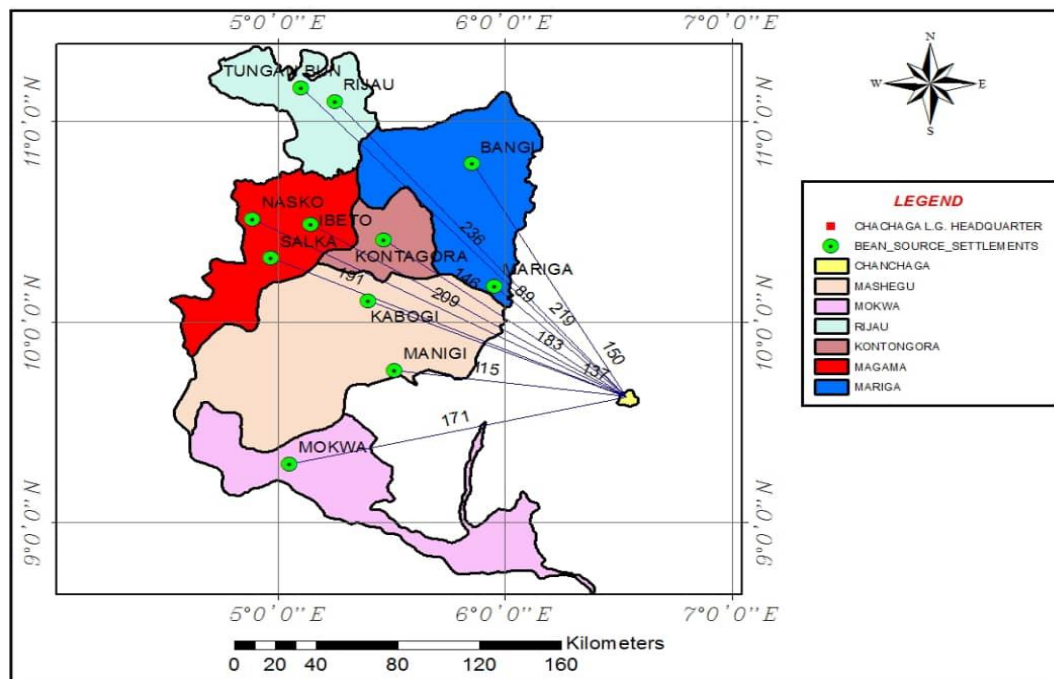


Figure 6: A contexture map of locations where beans are sourced

Source: Author's Digitized Work, 2023.

Like other staple food, beans supplied to cooks for the feeding programme are produced in large quantity by beans farmers association in Mokwa, Kontagora, Magama, Mariga, Mashegu and Rijau Local Government Areas of Niger State as shown in Figure 6. These six (6) Local Government Areas represents 24% of the entire LGAs where food for SFP are being sourced. In Figure 6, it's obvious that farmers in beans sourced locations travel a longer distance to supply their produce as compared with those supplying rice and yam tubers. Tungan Bun is the farthest location with an average distance of 236km to the distribution centre while Mariga, which is 89km to the Local Government Secretariat is the closest location where beans is sourced for SFP.

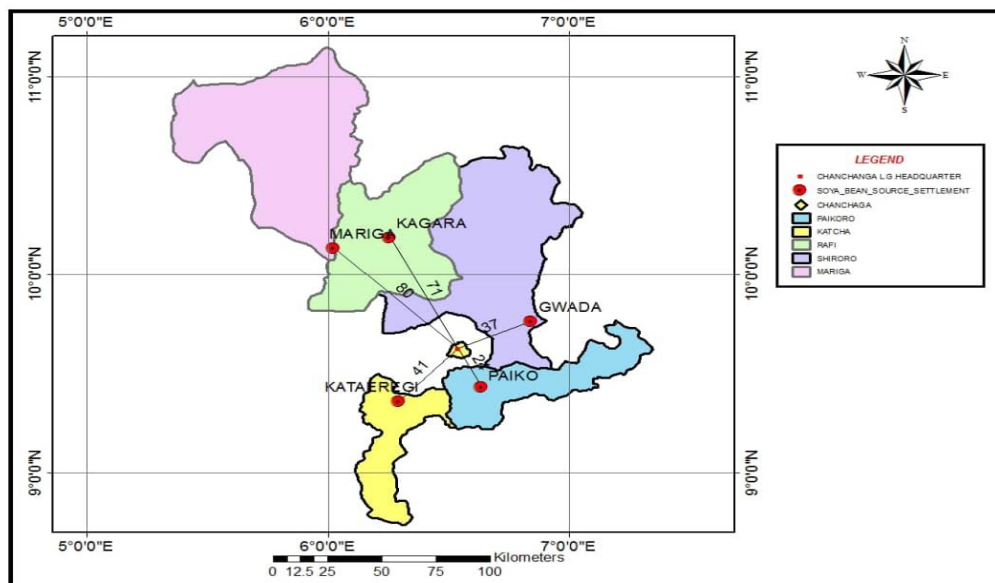


Figure 7: A contexture map of locations where soya beans are sourced

Source: Author's Digitized Work, 2023.

Like other farm produce, Figure 7 shows the locations of where soya beans are sourced for SFP in the State. Network of smallholder farmers in Kagara, Mariga, Gwada, Paiko and Kataregi settlements produce and supply soya beans used for the production of cheese in the school feeding menu. Theabovementioned settlements are located within 5 LGAs which constitutes 20% of the entire LGAs in the State where food for school feeding programmeare sourced.

From Figure 7, Mariga which is the farthest location covers an average estimated distance of 89km from the study area while Paiko covers an average estimated distance of 24km making it the shortest distance covered in transporting soya beans to Chanchanga LG Secretariat (distribution centre).

4.2 Transportation of Food for School Feeding Programme

From the study, it was discovered that the network of smallholder farmers in the 25 Local Government Areas of the Statetransport their farm produce from various locations to the distribution centre using trucks as a major mode of conveyance. The farmers put their farm produce (rice, beans and soya beans) in stitched bags to avoid pouring while the yam tubers are stacked on the truck for conveyance to the LG Secretariat for further distribution to the benefiting schools. Plate I shows a truck loaded with bags of beans ready to be offloaded at Chanchanga LG Secretariat (distribution centre). Cost of transportation of food from sourced

locations to the distribution centre varies depending on the distance of the locations to the distribution centre.

As for the conveyance of cooked food to pupils, cooks live within the community where the SFP benefitting schools are located therefore live near the schools, hence, do not need to cover long distances in order to convey the food to the schools.



Plate I. Mode of Transportation

4.3 Storage of Food for School Feeding Programme

The study revealed that both the protein and the carbohydrate contents supplied for school feeding programme in Chanchaga LG Secretariat are usually stored in enclosed environment. According to the Programme Manager, every week, over eighteen thousand (18,000) crates of fresh eggs are supplied from the poultry by a network of registered poultry farmers within the community and stored in designated warehouse for onward distribution to the schools benefiting from the feeding programme in Chanchaga LG.

In the same vein, bread supplied to make up the carbohydrate content in the menu is handled by master bakers association of Niger State. Delivery of bread baked by these registered bakers is taken once weekly and shelved in a store for onward distribution among benefitting schools. Like the aforementioned foods, bags of rice, beans and yam tubers are kept in warehouses until they are needed and also to facilitate distribution to various locations of the

benefiting schools. Plate II shows pictures of raw food items received in warehouses ready for distribution to the SFP benefitting schools in Chanchaga LG.



Plate II: Storage of Food for School Feeding Programme

Source: Author's Field Work (2023)

4.4 Distribution of Food for School Feeding Programme

This aspect of the study revealed how the raw foods are being distributed to the cooks from the distribution centre and how the cooks in turn convert the food into cooked food and distribute same to the eligible students in various SFP benefitting schools. In accordance with the approved national feeding guideline, the feeding menu contains both protein and carbohydrate contents. Addressing the protein contents, beef, which makes up protein content in the menu, is processed by Butchers Association of Niger State. From Plate III, the cooks have an allotment of 70-100 pupils whereby the pieces of meat are counted and tied in nylon bags and number of pupils written on each nylon bag. In the same vein, eggs are distributed to the cooks considering the number of the eligible pupils and allotted number to serve in each of the schools. Also, soya beans is processed and packaged into fried cheese (*wara*) by cheese makers for onward distribution to the cooks employed for the feeding programme. Plate III shows the process of packaging beef, eggs and fried cheese to be distributed to cooks for the purpose of school feeding in Chanchaga LGA.



Plate III: Protein Contents distributed to Cooks in Chanchaga LGA

Source: Author's Field Work (2023)

In furtherance of the food distribution, Plate IV addresses the distribution of carbohydrate contents in the food menu. From Plate IV, Loafs of bread, yam tubers and measures (*mudu*) of rice can be seen to be distributed to cooks in the various wards in Chanchaga Local Government. Loafs of bread are distributed at the distribution centre once weekly to the cooks and each loaf of bread, shared among eight (8) pupils. Recognisable from Plate IV, are the tubers of yam supplied by network of smallholder yam farmers in the State. The yam tubers are sourced and transported from different farm locations to Chanchaga Local Government Secretariat where they are distributed to the cooks engaged in the SFP.

In the same vein, network of smallholder rice farmers and millers in the State produce, mill and supply all the bags of rice needed for the school feeding programme in the State as

shown in Plate IV. The bags of rice are de-stoned however unpolished so as to retain nutrient benefits before supplying them to Chanchaga Local Government for onward distribution to the cooks that are saddled with the responsibility of preparing the food for the SFP benefitting schools.

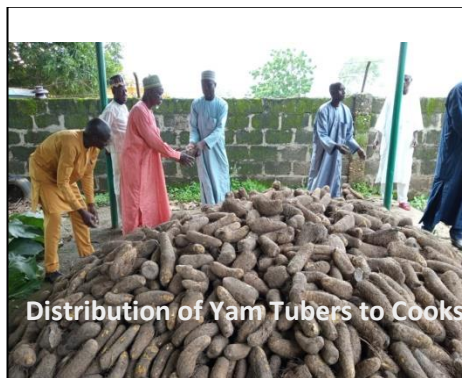


Plate IV: Carbohydrate Contents distributed to Cooks in Chanchaga LGA

Source: Author's Field Work (2023)

Following the distribution of raw food, Plate V shows the pictures of some of the cooks recruited for the school feeding programme in Chanchaga LGA. It is obvious in Plate V that foods cooked are packaged in plastic coolers for onward delivery service to the eligible pupils in the respective SFP schools. The characteristics of food served to pupils under the SFP programme was observed across the selected schools and the result is presented in Table 1. The result shows that four classes of food are prepared and administered to the students from Monday to Friday. Jollof rice and beef is served twice (Monday and Wednesday). Yam porridge and egg, beans porridge and bread, and bread and Soya Sauce are served once on Tuesday, Thursday, and Friday respectively. The study shows that the food served on daily basis had elements of four classes of food which include carbohydrate, protein, vitamin, fat

and oil. Hence, the food served can be adjudged to be rich for child development. A typical example of food served on Friday is depicted in Plate V.

Table 1: Types and Quantity of Food Served with Service Frequency

Food type	Class of food	Frequency per week	Qty. of food served
Jollof rice & beef	Carbohydrate/protein/vitamin/fat & oil	Twice	Two serving spoons
Yam porridge & egg	Carbohydrate/protein/vitamin/fat & oil	Once	One serving spoon
Beans porridge & egg	Carbohydrate/protein/vitamin/fat & oil	Once	One scoop
Bread and soya cheese sauce	Carbohydrate/protein/vitamin/fat & oil	Once	One soya cheese with sauce

Source: Author's Field Work (2023)



Plate V: Cooks serving cooked food to pupils in Kwasau and Barkin Sale Primary Schools

Source: Author's Field Work (2023)

5.0 Constraints to School Feeding Programme in Chanchaga Local Government Area

The study examined the constraints to effective implementation and success of the school feeding programme in Chanchaga LGA. The study identified nine constraints from extant review of literature and these challenges were presented to the head teachers and the cooks in each of the school for consideration using a five item Likert. Table 2 shows that corruption is the most challenging constraint to school feeding programme having recorded an index of 4.39 to rank 1st position. Poor remuneration of cooks ranked 2nd with an index of 4.25, while inadequate funding and high inflation ranked 3rd and 4th with an index of 4.10 and 4.05 respectively. These four factors were identified as major constraints to the successful implementation of the school feeding programme. In relation to high inflation and poor remuneration, the Cooks complained about the money for condiments not being enough to purchase the needed condiments hence making them spend out of their monthly stipend to augment. Going forward, corruption, funding, poor remuneration and inflation must be addressed to improve the success of the National school feeding programme.

However, political influence was the least ranked constraint with an index of 3.21 (9th); poor budgetary allocation (3.53) and inconsistency in food supply (3.65) were among the least ranked constraints to the National school feeding programme in Chanchaga LGA. Poor supervision ranked 6th with an index of 3.71 and poor storage facilities ranked 5th with an index of 3.87. The implication of having poor storage facilities is that food supplied by smallholder farmers will not be properly stored and preserved hence leading to spoilage and wastage of food for the school feeding programme. This invariably can lead to food not being enough for school feeding of the eligible pupils in the Local Government.

Table 2: Constraints to School Feeding Programme

Item	Weighted Sum	Mean	Rank
Corruption	79	4.39	1
Poor Remuneration of Cooks	77	4.25	2

Inadequate Funding	74	4.10	3
High Inflation	73	4.05	4
Poor Storage Facilities	70	3.87	5
Poor Supervision	67	3.71	6
Inconsistence in Food Supply	66	3.65	7
Poor Budgetary Allocation	64	3.53	8
Political Interference	58	3.21	9

Source: Author's Computation (2023)

6.0 Conclusion

The study underscores the pivotal role of logistics in the successful execution of the School Feeding Programme (SFP) in Chanchaga Local Government Area (LGA) of Niger State, emphasizing its heavy reliance on locally sourced food from farmers across the state, particularly rice and soya beans sourced from multiple LGAs. Transportation of raw food to the distribution center is predominantly facilitated by trucks, covering varying distances. The recruited predominantly female cooks gather raw materials at the distribution center, preparing cooked meals in their homes for delivery to schools. Identified challenges include corruption and inadequate remuneration for cooks. To mitigate these issues, the study recommends the State Government improve storage facilities to maintain food quality, ensuring fresh supplies for the students and overall success of the SFP.

7.0 Recommendations

The study recommends the following:

3. improve storage facilities to prevent spoilage and ensure fresh, high-quality raw materials for the school feeding program.
4. enhance cooks' remuneration to adequately motivate and incentivize them to continue providing their services for the successful implementation of the school feeding program.
5. strengthen logistics and distribution infrastructure, such as expanding distribution centers and transportation capabilities, to ensure timely and efficient delivery of food to the schools.

6. implement robust anti-corruption measures, including increased transparency, accountability, and monitoring mechanisms, to ensure effective and efficient utilization of the school feeding program's resources.
7. enhance community engagement, particularly with local farmers and cooks, to better understand their needs and challenges, and develop more targeted and effective strategies to support the long-term sustainability of the school feeding program.

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**TOPIC: AN APPRAISAL ON THE UTILIZATION OF BEST VALUE
PROCUREMENT (BVP) IN THE SELECTION OF CONTRACTORS (A STUDY OF
KADUNA STATE PUBLIC PROCUREMENT AUTHORITY)**

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Year:2023

ABSTRACT

The construction industry in Nigeria has a significant impact on the development of various sectors. Despite the existence of procurement regulations emphasizing the importance of Best Value in project procurement, the Nigerian construction sector is currently encountering challenges such as delays, cost overruns, cancellations, and re-awards, which are negatively affecting the overall economy of the country. This study evaluates how effectively Best Value Procurement is being utilized in the selection of contractors. A Case study approach was adopted for this study. Using survey questionnaires, data was collected from professionals working with Kaduna State Public Procurement Authority (KADPPA). Mean score ranking was adopted for data analysis via the use of SPSS statistical software. The results showed that 89.5% of the participants mentioned that Public Procurement Authority establishes the budget and opts for the lowest bidder with only 10.5% indicating they allow the contractors set the budget while KADPPA consider whether or not the factors presented by the contractors in the budget give value. This goes against the principles of Best Value Procurement as the client or client's representative who knows less is giving directions to the party (contractor) who is supposed to be an expert. Thus, this study recommends KADPPA adopt fully the practice of Best Value Procurement Method in the selection of Contractors.

Key words: Best Value Procurement (BVP), Low-bid, Procurement, Kaduna State Public Procurement Authority (KADPPA)

1.0 INTRODUCTION

The construction sector has proven to exert the highest level of impact on the development of virtually all nations of the world in terms of social development, industrialization, transportation, sustainable development, and urbanization (Salah et al., 2021). There can never be economic development in any nation without the contribution of the construction industry. No nation that has attended the helm of leadership and ever succeeded without the contribution of the construction industry. The construction sector, and especially with its employment potentials makes it a veritable platform for sustainable development especially if proper mechanisms are put in place for the growth of the sector (Isa et al., 2013).

As significant as the construction industry, it is not exempted from challenges such as high number of delays in completion time, budget overruns, disputes and claims (Joudi et al., 2018). It is upon this that Okolie et al., (2020) noted the need for the construction industry to continue to discover strategies, innovations and technologies that will best strengthen the infrastructural needs especially for countries that are at first stage level of development, seeking good standing for global competitiveness such as Nigeria. One most critical challenge in the construction industry is the selection of appropriate contractors suitable for adoption in the procurement process (Zubair & Zhang, 2022). Contractor selection is quintessential aspect in the construction sector which plays a significant role in the success or failure of projects. Therefore, it is necessary to identify methodologies adequate to the selection of contractors (Araujo et al., 2016).

In order to manage contractor selection problem and minimize bid collusion, vested interest, disagreements between stakeholders, poor quality of work, and breach in relationship due to the subjective bias in clients' selection criteria, countries such as; USA, Canada, Saudi Arabia, Germany, Finland, Netherlands, Botswana and Malaysia embraced the practice of Best Value Procurement in the Procurement of public infrastructures which has in most cases proving successful, especially in terms of value creation (Narmo et al., 2018; Shane et al., 2006; Wondimu et al., 2018).

Best Value Procurement (BVP) is a procurement approach that aims to prioritize quality and performance which is in oppose to the traditional procurement method of selecting contractor that primarily focus on lowest cost (Lines et al., 2020). BVP involves a rigorous evaluation process that takes into account various factors such as the contractor's track record, qualifications, value maximization, experience, and ability to deliver exceptional results (Joudi et al., 2018). It encompasses a broader framework that includes a risk management model, value management model, and a project management model designed to provide a comprehensive and holistic approach to project execution, ensuring that all aspects of the project are effectively managed and controlled with the aid of Best Value Performance Information and Procurement System (Buba & Hamid, 2019). Similarly, the Public Procurement Act, 2007 of the Federal Republic of Nigeria described the principal hallmarks of proficient public procurement to mean the economy of Best Value which imply more than just price in the procurement process (Bureau of Public Procurement, 2011). Despite the provision of Best Value in the procurement act, the Nigerian construction industry has

recorded poor project performance in terms of cost and time as noted by Hasnain & Jamaluddin, (2016). To prevent these challenges in construction projects, Gandu et al., (2023) opined that stakeholders must be meticulous in developing strategies to address the challenge of work quality, and work progress, and Value creation.

Simon-Peter et al., (2020) opined that the practice of Best Value Procurement can lead to transparency and accountability, high project performance, effective risk management and adequate value creation in the procurement chain in Nigeria.

1.1 Statement of the Research Problem

Nigeria is currently facing significant challenges in project execution, including delays, cost overruns, cancellations, and re-awards with detrimental effects on the economy, society, and overall development of the country (Nicholas, 2015). The inefficiencies in the application of contractors' selection criteria during the bidding processes exacerbate this issue (Okereke et al., 2022). Simon-Peter et al., (2020) noted that the inefficiencies in the application of adequate contractors' selection criteria arose as a result of the underutilization of Best Value Procurement in Nigeria. These researchers argued that factors that constitute the practice of 'Best Value' such as; Risk management, utilization of Performance Information and Procurement System, Life-cycle cost management, Quality performance and ability to manage value are not utilized in the contractor selection process, making the tendering process entirely 'price based'. This in turn negates the provision of the Public Procurement Act, 2007 of the Federal Republic of Nigeria which described the principal hallmarks of proficient public procurement to mean the economy of Best Value (Bureau of Public Procurement, 2011). Thus, literatures have not shown whether or not these hallmarks for proficient procurement are utilised in the contractor selection process, thereby constituting the gap for this study.

1.2 Aim and Objectives

The Aim of this study is to assess the factors considered in selecting contractors with a view to determine the extent of compliance with the economy of Best Value with the following objective;

- To assess the factors considered in selecting contractors in Kaduna State Public Procurement of construction projects.

- To determine the level of utilization of Best Value Procurement method of contractor selection in the procurement of public infrastructures in Kaduna State.

2.0 LITERATURE REVIEW

2.1 The concept of Best Value Procurement (BVP)

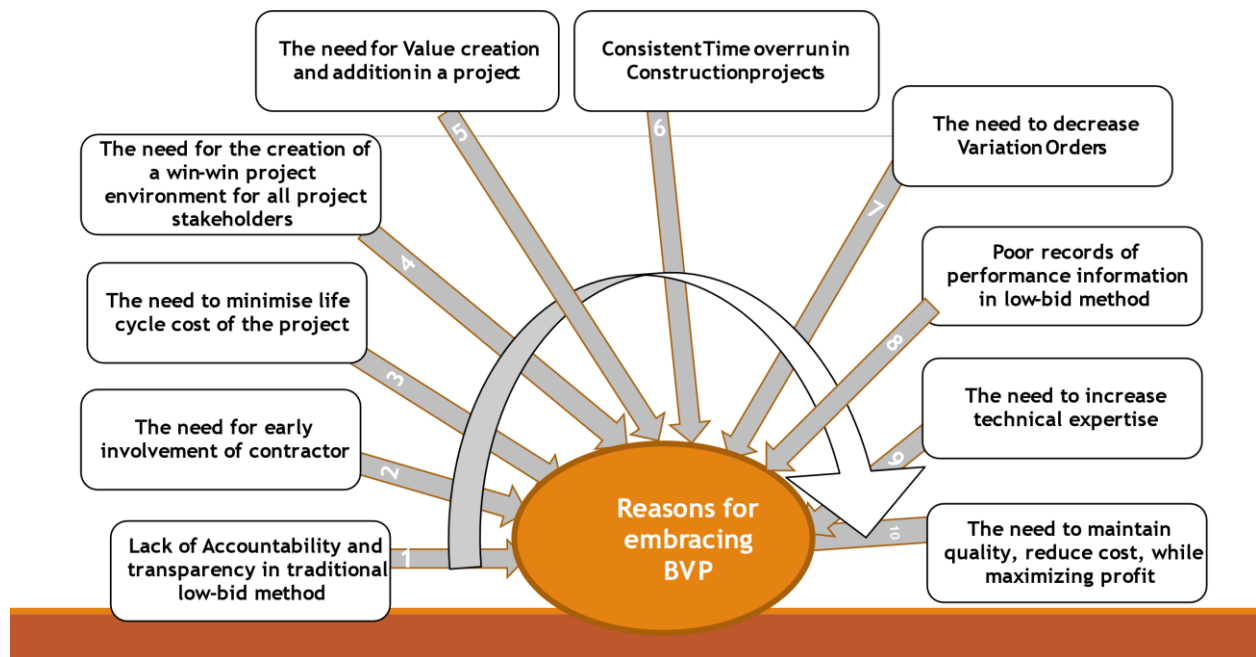
BVP is founded based on the concept that by using multiple criteria, contractors' competition and transparency increases, thereby making it more difficult for contractors to mislead clients in their tender. Many clients, in the traditional low-bid procurement method select contractors based on the lowest price in exchange for quality of work which had led to complex and risky decision making, misunderstanding, decreased quality of work, and hostile relationships (Kashiwagi et al., 2010). This process assumes that the contractors will provide good quality regardless of the price (Hasnain & Jamaluddin Thaheem, 2016). However, BVP placed emphasis on the fact that the supreme value of a contractor does not solely depend on cost criteria but on his ability to meet the explicit needs of the project due to the quality of his credentials (Wong et al., 2000).

The term Best Value Procurement (BVP) is a paradigm shift from the conventional low-bid procurement method which focuses on the utilisation of expertise to minimise the risk of non-performance in a project (Adeyemi & Kashiwagi, 2014). BVP considers factors rather than prices. Factors such as; Cost, risk, performance, quality control, health and safety, project control, current workload and delay claims (Hasnain & Jamaluddin Thaheem, 2016).

Thus, BVP can be defined as a procurement system that looks at factors such as; quality, expertise, ability to manage delay claims, risk management, and value maximization when selecting contractors, suppliers, and nominated sub-contractors.

2.1.2 Reasons for embracing Best Value Procurement

According to Adeyemi & Kashiwagi, (2014), the reasons for embracing best value procurement are thus;



Source: Adapted from Adeyemi& Kashiwagi (2014 and Simon-Peter Buba et al., (2020)

2.1.4 Comparison between Best Value Procurement and Traditional Low-bid

A wide gap exists between the traditional low-bid contractor selection method and the Best Value Procurement Approach. Simon-Peter Buba et al., (2020) noted the following while comparing BVP and the traditional low-bid method of contractor selection;

- **Risk Management:** BVP Utilises industry experts by minimising risks. Experts think in the best interest of the client, identify the risks associated with the project and are able to decipher the consequences of any decisions made (Kashiwagi et al., 2010). While in the traditional low-bid contractor selection method, the client negotiates the price of the contractor down, thereby increasing everyone's risk as the contractor may agree for the purpose of securing the contract and at the end abandon the project (Elsayah, 2016).
- **Understanding Client's Needs:** The contractor has a sole responsibility to deliver the project and to compete with his technical competence in terms of identifying and resolving problems with their accompanying prices in BVP. Based upon expertise, the contractor clarifies in detail the principles and methods to be adopted to meet the client's expectations (Chan et al., 1998). While in traditional low-bid contractor

selection method, Bid selection method hinders the quality of the product since tenderers are not inclined to fully understand the needs of the client from the onset.

- **Project Performance:**BVP identifies expertise as the only factor that can minimise risk of non-performance (Kashiwagi et al., 2010). In traditional low-bid contractor selection method, the Contractor's diminutive performance makes the whole project to suffer time and cost overruns which leads to legal issues like arbitration and litigation.
- **Contractors' profits:**Contractors can increase profits to 100% without cost overruns to the client (Kashiwagi et al., 2010). Low-bid results in poor working condition leading to increase costs to the client (Baloi & Price, 2003).
- **Encouraging Expert contractors:**BVP allows the contractor to specify and identify accurate solutions to a problem that may be encountered, and utilise expertise to lower the cost of the problem. Low-bid process assumes that all tenderers will provide an equal quality of work and as such the clients find the contractor who offers to undertake the project at the lowest price and suffer cost overrun later on (Flyvbjerg et al., 2018).
- **Manage, Direct, and Control of the contractor:** BVP Does not use the contract to manage, direct, and control the contractor. while the low-bid which is Price based witnesses' lower performance because the client and or client's representative who knows less is giving directions to the party (contractor) who is supposed to be an expert (Kashiwagi et al., 2010). BVP is Self-monitoring while low-bid approach Need to be monitored by client representatives.
- **Early involvement of Contractor:** In BVP, the Contractor is involved from pre-contract Stage to post contract while the contractor is only involved at the post contract stage in low-bid approach (Lamprou & Vagiona, 2018).

3.0 METHODOLOGY

This study adopts a Quantitative method. A survey Questionnaire was utilized for the purpose of data collection. The results of this Quantitative approach were analyzed using descriptive statistics with the aid of SPSS analysis software where mean score ranking method of descriptive statistic was utilized as a tool for data analysis. The study population are construction professionals working with Kaduna State Public Procurement Authority. This

study was conducted in Kaduna state, a metropolitan city in north-western Nigeria. The choice of Kaduna as the study area is due to Kaduna State's geographical diversity, economic significance, social complexity, as well as educational infrastructure (KADPPA, 2023), making it a compelling choice as a study area. Kaduna is a relatively 'built – up' environment with many infrastructures like roads, bridges, estates, government establishments, all kinds of private developments, schools, hospitals, shopping malls to mention a few. All these infrastructures are the handiwork of construction. As such Kaduna is a better place to obtain data for this study. While Kaduna State Public Procurement Authority (KADPPA) is utilized solely for the purpose of data sampling, thus utilizing a purposive sampling. Only construction professionals working with KADPPA constituted the sample frame for this study. KADPPA is a procurement body that is saddled with the responsibility of approving procurement strategies such as; contractor selection, consultants' selection, project performance monitoring and supervision, payment approvals, and commissioning of all state-owned projects in Kaduna state. The mission of KADPPA is to ensure that Kaduna State gets Best Value for its money in public procurement through adherence to highest Standards, consistent to international best practice (KADPPA, 2023). Their response is thus valid due to their involvement in almost every aspect of public procurement of construction projects whose mission is to promote Best Value in the Procurement of Public Infrastructure.

A pilot survey was conducted on the categories of professionals working with Kaduna State Public Procurement Authority in order to have a representation of all the professionals in the construction industry. The survey revealed that there are 54 permanent staffs and more than ten (10) different construction professionals represented in KADPPA such as Architects, Quantity surveyors, Civil Engineers, Land surveyors, Structural Engineers, Mechanical Engineers, Electrical Engineers as presented in the table 1 below.

Table 1. Representation of Professionals working with KADPPA

S/N	PROFESSION	% WORKING WITH KADPPA
1	Architects	15.80
2	Quantity Surveyors	15.80

3	Civil engineers/Structural Engineers	10.60
4	Electrical Engineers	10.50
5	Mechanical Engineers	5.30
6	Building Engineers	5.31
7	Computer Engineers	5.30
8	Surveying And Geoinformatics	5.30
9	Land Surveyors	10.50
10	Others (civil servants/administration staffs)	15.50
TOTAL		100%

Source: Field Survey (2023)

Fifty-four (54) number of questionnaires were administered to staffs working at KADPPA and 38 (70%) were returned and used for the purpose of analysis.

4.0 DATA PRESENTATION AND DISCUSSION

4.1 Respondents' years of experience in the construction Industry

Table 2 is a presentation of the years of experience of the respondent in this study. From the table, the following are the percentages of respondents' years of experience captured in this study: 1-5 years (47.40%), 6-10 years (31.60%), 10-15 years (5.3%), 16 years and above (15.8%). This indicates that majority of the respondents are above five (5) years of experience in the construction industry. The responses received from the respondents is thus reliable and worthy of generalization as majority of the respondents are above 6yrs of experience in the construction industry.

Table 2: Years of experience in the construction Industry

YEARS OF EXPERIENCE	PERCENTAGE OF RESPONDENTS
1-5	47.40
6-10	31.60
11-15	5.20
16 and above	15.80
TOTAL	100%

Source: Author's field Survey, 2023

4.2 Factors Considered in Selecting Contractors

Table 3 shows the perception of all the professionals working with KADPPA on the factors considered in selection of contractors in the construction Industry. Price ranked first with Mean score ranking of 4.316, Time contractors' ability to manage project scope effectively ranked 2nd with mean score ranking of 3.895, The contractor's ability to manage risk was ranked 3rd with mean score ranking of 3.790, time performance of the contractor was ranked 4th with mean score ranking of 3.685, Quality performance of the contractor ranked 5th with mean score ranking of 3.684, and value management was ranked 6th with mean score ranking of 3.580. It can be said that the construction professionals agree that all the factors presented are paramount in the selection of contractors for improved project delivery in the construction industry.

Table 3 Factors Considered in Contractor Selection in Kaduna

Factors	Scale				Total	Mean	Rank
	1 5	2	3	4			
Price the contractor is willing to execute the project	0	0	6	14	18	38	4.316 1 st
Time performance of the contractor in the past projects	6	0	8	10	14	38	3.685 4 th
The contractor's ability to manage project scope effectively in time past	2	2	8	12	14	38	3.895 2 nd

The contractor's ability to identify and manage risks and uncertainties in past projects	2 10	2	8	16	38	3.790	3 rd
Quality performance of the contractor	4 14	2	10	8	38	3.684	5 th
Value creation and value management of the contractor	4 12	6	4	12	38	3.580	6 th

Source: Author's field Survey, 2023

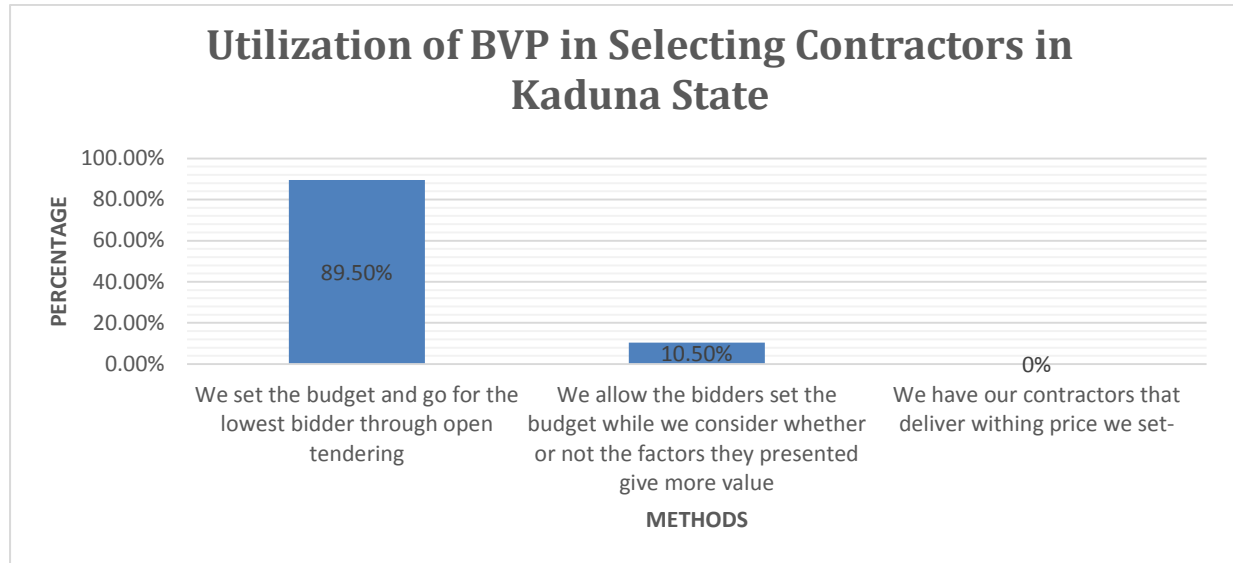
4.3 Awareness of Best Value Procurement Method in Selecting Contractors

The findings revealed that 94.7% of the respondents have been involved in the procurement of public infrastructure in the state while only but 5.3% of the total population indicated that they have never been involve in public procurement directly. Similarly, 57.9% of the respondents are aware of the existence of BVP method in contractor selection while 42.1% are not aware. This shows that majority of the respondents are aware of the provision of the Procurement Act, 2007 as well as the application of Best Value Procurement principles in selecting contractors.

4.4 Utilisation of Best Value Procurement Method in Selecting Contractors in Kaduna State

Chat 1 shows that 89.5% of the construction professionals indicated that they set the budget and go for the lowest Bidder, 10.5% indicated that they allow the bidders set the budget while they consider whether or not the factors presented give value. This reveals that the existing contractor selection method is priced based with very little indication of the existence of Best Value Procurement Method.

Chat 1: Utilization of Best Value Procurement Method of Contractor Selection



Source: Author`s field Survey, 2023

4.5 Discussion of Findings

From the analysis of the findings, price is seen as the most rated factor in the procurement of public infrastructures in Kaduna state. This is in line with the findings of Simon-Peter Buba et al., (2020) who concluded that the existing procurement method in Nigeria is price based. Hence, where contracts are awarded based on the lowest bid, there is lack of flexibility and lack of willingness to accept changes and new innovations that will accommodate the adoption of Best Value Procurement (BVP). Similarly, Kashiwagi et al., (2010) indicated that when the procurement method is price-based, as the case of Kaduna State, then the level of Value creation, Innovation and transparency is low.

5.0 SUMMARY OF FINDINGS, CONCLUSSION & RECOMMENDATION

5.1 SUMMARY OF FINDINGS

This study is an appraisal on the utilization of Best Value Procurement in the selection of Contractors in Kaduna State. The respondents agreed with the following determinants of Best Value procurement such as; Price the contractor is willing to execute the project, the contractor`s ability to manage project scope, the contractor`s ability to manage risks and uncertainties in past projects were ranked highest with mean score ranking of 4.316, 3.895, and 3.790 respectively while factors such as: Value creation and value management of the contractor, Quality performance of the contractor, Time performance of the contractor in the

past projects were ranked lowest with mean score ranking of 3.580, 3.684, and 3.845 respectively.

It was observed that Best Value Procurement Method is underutilized in the selection of contractors in Kaduna State as 89.5% of the Construction professionals working in Kaduna State Public Procurement Authority (KADPPA) indicated that they set the project budget and go for lowest-bidder. Similarly, the client or client's representative who knows less is giving directions to the party (contractor) who is supposed to be an expert, and when that is done, Kashiwagi et al., (2010) concluded that such is not the practice of Best Value Procurement.

5.2 CONCLUSION

The findings of this study reveals that the existing method of contractor selection in Kaduna State is highly Price-base, thus, the extend of utilization of Best Value Procurement (BVP) method of contractor selection is very low in Kaduna State Public Procurement.

5.2 RECOMMENDATION

This research recommends that when it comes to construction projects, the Kaduna State Public Procurement Authority (KADPPA) should fully adopt the Best Value Procurement Method in the selection of Contractors by considering Factors rather than cost in the selection of contractors across the state.

In areas for further research, this research was carried out in Kaduna State only. This study can be replicated in other states in Nigeria to have a generalization. The extend of utilization of BVP can be tested in other industries such as mining, transportation, banking and finance, and agriculture also.

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7.0 APPENDIX 1: QUESTIONNAIRE

TOPIC: Utilization of Best Value Procurement method of Contractor Selection in the Procurement of Public Infrastructure in Kaduna State, Nigeria.

BVP is a practice of selecting a contractor where the main focus is not necessarily price but factors such as the performance of the contractor, price, risk management, value creation, etc.

The above topic requires first hand and reliable information from construction professionals and civil servants directly involved in Kaduna State Procurement. This work is entirely for academic purpose. Thank you for your willingness to partake in this research. Your input is valuable and will go a long way in achieving the aim of this research.

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Institution: KADUNA STATE UNIVERSITY.

SECTION A: GENERAL INFORMATION

Kindly tick the box where appropriate

- Profession? Architect ☐ Quantity Surveyor ☐ Civil Engr ☐ Structural Engr. ☐
Electrical Engr. ☐ Mechanical Engr. ☐ Others (please specify).....
- Years of experience in construction/procurement practice: 1-5yrs ☐ 6-10yrs ☐
11yrs and Above ☐

SECTION B: FACTORS CONSIDERED IN CONTRACTOR SELECTION IN KADUNA

Kindly rank the following factors in order of priority such as;

1= strongly disagree 2= disagree 3= Not sure 4= Agree 5= Strongly agree

Factors	RANK				
	1	2	3	4	5

Price the contractor is willing to execute the project

Time performance of the contractor in the

past projects

The contractor's ability to manage project
scope effectively in time past

The contractor's ability to identify and
manage risks and uncertainties in past
projects

Quality performance of the contractor

Value creation and value management of the
contractor

SECTION C: UTILISATION OF BEST VALUE PROCUREMENT (BVP) IN KADUNA STATE PROCUREMENT

Tick where appropriate [✓]

1. Have you heard '**Best Value Procurement**' (BVP)? Yes [] No []
2. What method do you adopt in selecting contractors?
 - a) We set the Budget and go for the lowest Bidder through open advertisement []
 - b) We allow the bidders set the budget while we consider whether or not the factors they present give more value []
 - c) We have our contractor(s) we normally select that deliver the project within the cost we budget []

What other method do you adopt? (please Specify)

COMPARISON BETWEEN CONVENTIONAL AND LATERIZE CONCRETE FOR SUSTAINABLE BUILT ENVIRONMENT

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ABSTRACT

In the quest for sustainable development, the construction industry is increasingly exploring alternative materials and practices to reduce its environmental impact. This research aimed to compare the compressive strength of normal concrete and laterized concrete cubes, with the objective of evaluating the potential of laterized concrete as a sustainable alternative for the built environment. The research methodology involves the procurement of raw materials including cement, sand, aggregate, and laterite soil. Concrete cubes were casted using both normal concrete mix and laterized concrete mix, with varying proportions of laterite soil comprising 0% 5% 10% 15% 20% and 25% respectively, replacing cement. These cubes were cured under controlled conditions and subjected to compressive strength testing at different ages of curing. The compressive strength data obtained was analyzed to assess the influence of different proportions of laterite soil on the compressive strength of the laterized concrete in comparison to normal concrete. The outcomes of the research indicate that laterized concrete exhibits less comparable compressive strength to normal concrete, hence, it can serve as a viable alternative for non-load bearing walls in the built environment. Further research can expand upon the study by exploring other chemical, mechanical properties, durability aspects, and long-term performance of laterized concrete to comprehensively evaluate its suitability for diverse construction applications.

Keywords: built environment, compressive strength, environmental impact, laterized concrete, sustainable development

1. INTRODUCTION

Concrete is a compound material encompassing cement, aggregate and water which is added in various proportions based on the preferred use. The aggregate is mainly coarse, comprising granite, gravel or crushed rocks such as limestone, alongside fine aggregate such as river sand and others. Portland cement is usually used as a binder in the matrix and different additives and chemical admixtures such as silica fumes, fly ash, and ground granulated blast furnace slag may also be added to yield concrete with improved strength and durability. Due to the enormous increase in the cost of producing concrete using these conservative materials such

as cement, fine aggregate and coarse aggregate in Nigeria and the world over, engineers and other builders and material researchers have continuously been working on alternative, low-cost and freely available materials that would function as seamless replacements for such materials while still meeting the established requirements for concrete in the construction industry in order to also reduce its environmental impact in the built environment for sustainable development. According to Encyclopedia Britannica (2010), Laterite is a soil that is rich in [iron oxide](#) and resulting from a wide variety of rocks weathering under powerfully oxidizing and leaching conditions. It is mainly a tropical soil that is amply available in the tropical belts of the world and especially abundant in Nigeria. The use of laterite as a partial replacement of fine aggregate had particularly received much attention in Nigeria and elsewhere from researchers for a long time, recently, there are notable efforts from Arumet *et al.*, (2023), Mali *et al.*, (2022), Harshith *et al.*, (2020), Afolayan *et al.*, (2019), Shaik Manzoore *et al.*, (2019), Babitharani *et al.*, (2019) Manu and Srivathsa (2017) Uttarkar (2017); and others. In contrast laterite has hardly been used as a direct replacement for cement in concrete, possibly owing to its very low content of silica (resulting from leaching during its formation), except in its calcined form, which may be why the authors of this work came into contact with only one (John *et al.*, 2019) research paper on calcined laterite and not for direct un-calcined laterite replacement. Calcination is a process that requires elevated temperatures, in which the authors reasoned will impact negatively on the environment and hence, is unsustainable when burnt in large quantities, therefore, unsustainable for any meaningful development. While laterite is abundant in Nigeria, it is known to be highly versatile and there could be a possibility of the laterite in our region containing a higher percentage of silica which is an important constituent of cement. We thought to replace cement in concrete with the much available source and cheap in cost laterite in Kaduna –Zaria express way which Julius Berger plc excavated and dumped besides the road due to its probable unsuitability for road construction. Zaria- Kaduna region is located in North-Western part of Nigeria which is a high producer of grains and has a rich source of laterite sand also. Therefore, the objective of this paper is to determine the compressive strength of laterized concrete (composed of partial replacement of cement with un-calcined laterite) and compare it with that of conventional concrete.

2. MATERIALS AND METHODS

1. Materials

Cement: Dangote 3X Ordinary Portland Cement (OPC)(Grade 42.5N) meeting the requirement of EN 197-1(2011)

Coarse aggregates: Crushed granite bought from a quarry close to NuhuBamali polytechnic Zaria of maximum size of 14.5mm is used which conforms to B.S. 882 (1992) requirements

Fine aggregates: The sand used was clean, sharp river sand from a Gobirawa river which is at the boundary of NuhuBamali polytechnic Zaria with Gobirawa Village, bought from the community, it is free from clay, loam, dirt and organic or chemical matter of any description. It was sieved through the 4.75mm sieve and 100% retained on the 75 μ m sieve.

Water: The water was clean and free from any visible impurities. It was gotten from a borehole close to the Civil Engineering materials laboratory. It conformed to BS3148 (1980) requirements.

Laterite soil (locally available): The laterite that was used for the experiment was gotten from Kaduna-Zaria express way close to NuhuBamali polytechnic Zaria. The laterite was sieve with sieve number two, size twelve to ensure that other solid substance was not included in the laterite. It is not subjected to another sieving to get the finest sizes but used in its original form.

Some of the properties of the above constituent materials are shown in Table 1

Table 1: Properties of Concrete Constituents

Materials	Source	Properties
Cement	Dangote Ordinary Portland Cement (OPC) grade 42.5N	Specific gravity is 3.10
Laterite	Locally available	Specific gravity is 2.68
Coarse Aggregate(CA)	Locally bought Crushed granite stones	Specific gravity is 2.73
Fine Aggregate(FA)	Locally bought river sand	Specific gravity is 2.59
Water	Borehole water	PH value is 7.20

2 Methods

In this investigation, the % of replacement of laterite was made keeping the W/C ratio and mix proportion constant. The mix ratio used was 1:2:4 (one-part cement to two parts of sand to four part of coarse aggregate) at constant water cement ratio of 0.63. The total amount of materials needed for each mix was determined in accordance to BS8500 by the assumption of grade C20 (nonstructural applications) concrete with target compressive strength of 16N/mm^2 . For the purpose of this study, concrete cubes of $150 \times 150 \times 150\text{mm}$ were produced under laboratory condition i.e. 8 cubes for each percent replacement as specified in BS1881-108 (1983). The cement was replaced by the laterite at 0%, 5%, 10%, 15%, 20% and 25%. The 0% replacement served as the conventional (normal) sample for the study. To prevent deficiency due to wastage, compaction and swelling of aggregates, 10% was allowed on the materials. The concrete materials used for each batch of eight cubes is as shown in Table 1.

The cubical specimens were cured according to standard procedures. At succeeding days i.e., 7, 14, 21 and 28 days the cubes were crushed using a compression testing machine to determine the compressive strength in line with BS12390-3(2009)

Table 1: Concrete Materials for Production of a Batch of Eight Cubes

Concrete Materials (Kg)	Laterite 0%	Laterite 5%	Laterite 10%	Laterite 15%	Laterite 20%	Laterite 25%
Cement	9.60	9.12	8.64	8.16	7.68	7.20
Laterite	0.00	0.48	0.96	1.44	1.92	2.40
Fine	18.60	18.60	18.60	18.60	18.60	18.60

Aggregate

Coarse	38.00	38.00	38.00	38.00	38.00	38.00
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Aggregate

Water	5.96	5.96	5.96	5.96	5.96	5.96
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Water/Binder	0.63	0.63	0.63	0.63	0.63	0.63
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3. RESULTS AND DISCUSSION

The average weight of cubes as well as their compressive strengths for each curing age corresponding to percentage replacement of laterite in the concrete cubes are shown in Table 2

Table 2: Average weight and Compressive Strength for Curing Ages at Percent Replacement

Percent Replacement (%)	Average Weight of Cubes at Cured age(Kg)				Average Compressive Strength (N/mm ²)			
	7days	14day	21days	28days	7days	14days	21days	28days
	s							
0	8.33	8.32	8.52	7.97	14.44	15.77	15.88	18.44
5	8.01	7.19	8.39	7.89	13.33	15.33	15.55	16.11
10	7.64	7.65	7.65	8.24	12.00	13.40	16.60	17.55
15	8.27	8.13	7.54	7.68	10.97	9.88	9.88	11.44
20	7.92	7.90	7.78	7.59	9.44	12.88	11.22	10.33

25 7.63 8.46 8.13 7.60 8.04 9.98 12.22 9.33

Looking analytically at Table 2 as well as at Figure 1, the following observations are made: At the 7th day, all the laterite containing concrete cubes exhibited lower compressive strength compared to the conventional concrete, which indicates that working with such replaced cement concrete at that age will not be ideal, in concreting where early strength is required. This downward trend was also exhibited by the laterite replaced cement concrete at curing ages 14 and 21 days, though after the lowest dip of the compressive strength (9.88N/mm^2) at 15% replacement, there appears to be an increase at 20% replacement before the downward trend continues at 25% replacement.

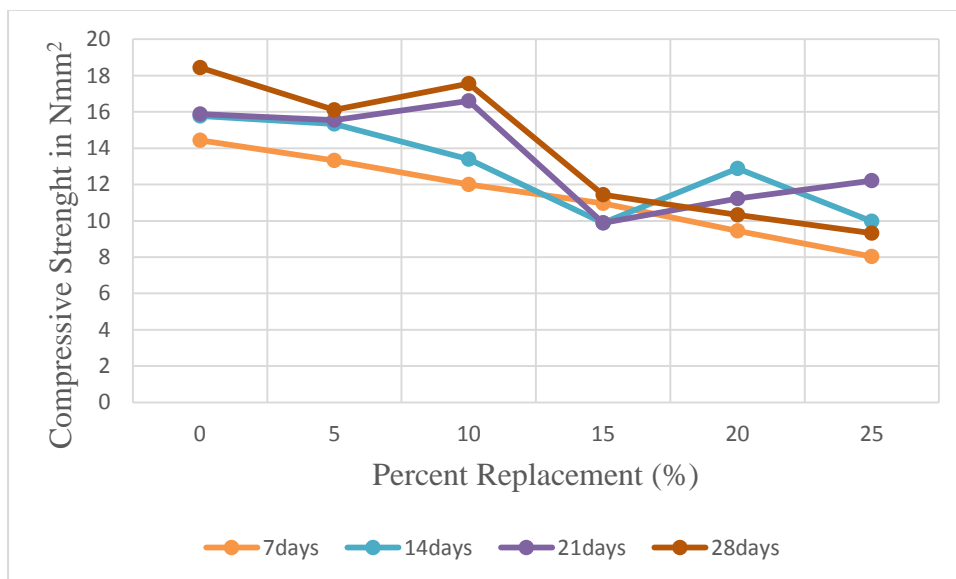


Figure 1: Variation of Compressive Strength with Percent Replacement of Laterite at Different Curing Ages

At 28 days the laterized concrete displayed lesser compressive strength in comparison to the conventional concrete, however, the normal as well as the 5% and 10% replaced cement concrete cubes had compressive strengths of respectively 18.44N/mm^2 , 16.11N/mm^2 and 17.55N/mm^2 , which are higher than the target compressive strength of 16N/mm^2 . Therefore,

10% replaced particular laterite in cement can be said to be the optimum amount in concrete making for non-structural application.

4.CONCLUSION AND RECOMMENDATIONS

The comparison between conventional and laterize concrete for sustainable built environment. has been undertaken in this paper and the following findingshas been made:

All the laterized concrete cubes displayed lower compressive strength when compared to the conventional concrete at the 7th day of curing.

At curing ages 14 and 21 days, the laterized concrete cubesexhibited lower compressive strength than the conventional concrete, with the lowest at 15% replacement, then an increase at 20% replacement before the downward trend continues at 25% replacement.

At 28 days the laterized concrete had lesser compressive strength in comparison to the regular concrete, nevertheless the conventional as well as the 5% and10% replaced cement concrete cubes had compressive strengths that are higher than the target compressive strength of 16N/mm² (C20)

Therefore, the specific 10% laterite replaced cement can be said to be the optimum amount in concrete making for non-structural application.

This research can be said to be a feasibility study of the use of direct laterite replacement of cement in concrete making without recourse to any modification or additives. More research and development in this area is necessary order to better understand the properties (chemical and mechanical) of this laterite and its concretes.Researches on strength development and durabilityis also recommended.

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INNOVATIVE TECHNOLOGY PRINCIPLE OF REPAIR IN CIRCULAR ECONOMY FIRMS FOR SUSTAINABLE SOCIO-ECONOMIC GROWTH AND NATIONAL DEVELOPMENT

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ABSTRACT:

Circular economy is an emerging innovative technology that is attracting attention in the recent time. Circle Economy is about optimizing resources use, promoting sustainable growth, and reducing waste and pollution, these are some principles of circular economy which includes, principle of Repair, Reduce, Regenerate, Refurbishing, and Reuse. The principle of repair is very peculiar because of the peculiar environmental and economic benefits. Hence, this study aims at exploring the innovative technology principle of repair in circular economy firms for socio-economic growth and national development. The study employs a desk review of extant relevant literature for its methodology. The study discusses the components of repairs and also highlights the types and benefits of this technological principle of repair, to create new business opportunities, promote resource efficiency, and contribute to the shift towards a more sustainable and circular economic system. Furthermore, the study expatiates on the barriers to repair principle and role of personnel within the circular economy to foster socio-economic growth and national development, hints to promote circular Economy and suggestions for further studies such as other principles of Circular Economy is made.

Keywords: Circular Economy, Innovative Technology, Principles of Repair, Sustainable, Socio- Economic Growth, National Development,

INTRODUCTION

In an era marked by unprecedented consumption and resource depletion, the imperative for transitioning towards sustainable socio-economic models has never been more pressing (Smith & Johnson, 2023). The Circular Economy paradigm has emerged as a beacon of hope, offering a framework that emphasizes resource efficiency, waste reduction, and regenerative practices (Ellen MacArthur Foundation, 2019). At the heart of this paradigm lies the principle of Repair – a fundamental concept that challenges the linear "take-make-dispose" model by promoting the extension of product lifecycles through maintenance, refurbishment, and remanufacturing (Stahel, 2016).

This conceptual article delves into the innovative intersection of Repair within the Circular Economy context, exploring its potential to catalyse sustainable socio-economic growth and

national development. By reimagining products not as disposable commodities but as valuable assets with the potential for continual renewal, Repair aligns with the ethos of sustainability, resilience, and inclusivity (Geissdoerfer et al., 2017). Moreover, it presents a unique opportunity to harness technology as a catalyst for transformative change, leveraging advancements in materials science, digitalization, and automation to streamline repair processes, enhance product durability, and minimize environmental impact (Tukker, 2015).

Despite increasing awareness of environmental degradation and resource scarcity, traditional linear economic models continue to dominate, characterized by rampant consumption, waste generation, and depletion of finite resources. (Patel et al., 2022). This linear "take-make-dispose" approach not only perpetuates ecological harm but also exacerbates socio-economic inequalities and undermines long-term prosperity. (Chang et al., 2023)). Within this context, the urgent need for a paradigm shift towards sustainable socio-economic models becomes evident. The Circular Economy offers a promising alternative, emphasizing the importance of resource efficiency, waste reduction, and closed-loop systems. (Ramos et al., 2020). However, widespread adoption of principles faces several challenges, including limited technological infrastructure, ingrained consumer behaviours, and inadequate policy support. (Griggs et al., 2014) While Repair aligns with the goals of resource conservation, waste reduction, and sustainable consumption, its integration into mainstream economic practices remains hindered by various barriers. (Karthi et al., 2020). These barriers include a lack of incentives for manufacturers to design products for reparability. (Andrew et al., 2012), limited access to repair services and information.

Moreover, the socio-economic implications of embracing Repair within the context are not fully understood. Questions remain regarding its potential impact on job creation. Additionally, the role of technology in facilitating repair processes and scaling circular business models requires further exploration. (Nguyen et al., 2022).

LITERATURE REVIEW

Repair Principle and Sustainable Socio-Economy Growth

The repair principle is a crucial element of a circular economy, aiming to extend the lifespan of products and reduce waste. It involves maintaining, refurbishing, and repurposing products to retain their value and functionality. Repair principle and sustainable Socio-Economic,

these studies provide evidence of the benefits and challenges of implementing circular economy principles in various industries, highlighting the importance of repair as a strategy to achieve a more sustainable and efficient use of resources. Empirical evidence suggests that repair initiatives, such as community repair workshops and online repair platforms, contribute to waste reduction and resource conservation by extending the lifespan of products and diverting them from landfills. (Cooper 2017), observed that Community-based repair initiatives contribute to waste reduction, resource conservation, and increased product. Life Cycle Assessment of Remanufacturing Activities Comparative Study by Mont (2016) Also indicates that remanufacturing activities, which involve disassembling, repairing, and reassembling products, have a positive environmental impact by reducing energy consumption and greenhouse gas emissions compared to manufacturing new product, the economic benefits of repair and refurbishment activities, including job creation, cost savings for consumers, and revenue generation for businesses and Remanufacturing reduces energy consumption and greenhouse gas emissions compared to manufacturing new products Bocken et al. (2014).

In a study by Kagermann et al. (2013) concluded that Digitalization and automation promote innovation and competitiveness in industries, leading to increased efficiency and cost savings. Moreover, digital platforms powered by innovative technologies can connect repair service providers and customers, facilitating the sharing of repair knowledge, and creating new business models for the circular economy. It also highlights the components, barriers for implementing repairing in different sectors.

Components of Repair Principle

The repair principle can be broken down into several components:

First the design for longevity and reparability Products should be designed to be durable, easy to maintain, and repairable. This includes using standardized parts, providing repair manuals, and incorporating modular design to facilitate disassembly and repair. (Guo, et al., 2020).

Secondly Maintenance and diagnostics Regular maintenance and timely diagnosis of malfunctions are essential for prolonging the lifespan of products. This can be achieved through monitoring systems, predictive maintenance, and user education on proper usage and care. (Geng, et al., 2017).

Remanufacturing and refurbishment: Remanufacturing involves disassembling, inspecting, repairing, and reassembling products to restore them to like-new condition. Refurbishment refers to cleaning, repairing, and updating products to improve their performance and extend their lifespan. (Zhang, et al., 2019).

Upgrading and repurposing: Products can be upgraded with new features or repurposed for alternative uses to extend their usefulness and prevent waste. This can include software updates, accessory additions, or creative repurposing of outdated products. (Hasselqvist, & Henriksson, 2020)

End-of-life management: When products reach the end of their usable life, their components should be recovered and recycled to the greatest extent possible. This can involve disassembly, materials separation, and recycling or reuse in new products. By incorporating these components, the repair principle can contribute to a circular economy by reducing resource consumption, promoting sustainable production, and creating new business opportunities in repair, remanufacturing, and recycling. (Mont, G. 2016).

Types of Repair Principle

There are several types of principles related to repair in the context of a circular economy, these include First the Direct repair this involves fixing a product to restore it to its original functioning condition. Direct repair can include replacing broken parts, mending tears, or addressing other issues that interfere with the product's performance.

Secondly Up cycling, this involves repurposing a product or its parts to create a new product with higher value or different functionality. Up cycling can help to extend the life of a product's materials and reduce waste.

Thirdly the Modular repair this approach involves designing products with modular components that can be easily replaced or upgraded. Modular repair allows for easier maintenance and customization, extending the product's life. (Ma, et al, 2021).

Benefits of Repair Principle

Environmental benefits is Reducing waste Repairing products instead of disposing it helps to reduce waste sent to landfills or incinerators. Conserving resources is Repairing products

extends their life, which in turn conserves natural resources and reduces the need for new production.

Economic benefits is Cost savings Repairing products can often be more cost-effective than replacing them, especially when considering the cost of raw materials, labour, and transportation. Job creation the repair industry can create new job opportunities in areas such as repair services, refurbishment, and recycling.

Social benefits is Product longevity repairing products extends their useful life, which can lead to greater customer satisfaction and loyalty. Accessibility is Repair services that make products more accessible to people who cannot afford new products or prefer to buy second-hand (cooper 2019)

Role of Repair Principle Personnel

The role of personnel is crucial in implementing the repair principle in a circular economy. Well-trained and skilled personnel are essential for conducting maintenance, diagnostics, remanufacturing, refurbishment, upgrading, repurposing, and end-of-life management activities. Here are some ways in which personnel play a significant role in the repair principle

Technicians and mechanics: These professionals perform maintenance, repair, and remanufacturing activities. They must have technical knowledge and skills to disassemble, diagnose, repair, and reassemble products. (Kim, et al., 2017).

Engineers and designers: These professionals play a vital role in designing products for longevity, reparability, and end-of-life management. They must incorporate circular economy principles into product design, development, and manufacturing processes.

Service personnel: These professionals interact with customers, providing information on proper product usage and maintenance. They also facilitate the return of products for repair, remanufacturing, or recycling. (Chan et al., 2023).

Barriers to Innovative Technology adoption in Repair principle of Circular Economy

Despite the potential benefits of the Innovative Technology outlined above, several challenges exist that hamper its integration in the Circular Economy. Currently, the Innovative Technology landscape is very fragmented and suffering from numerous technical

challenges, including scalability, lack of interoperability and adaptability of services, and increasing complexity (Miaoudakis et al., 2020).

In a recent study, Ingemarsdotter et al. (2020) stated that the design of interoperable, adaptable, and upgradeable software and hardware are key Innovative Technology -specific challenges. The implementation of Innovative Technology-enabled Circular Economy business models is also curbed by cybersecurity risks, privacy concerns, a lack of competencies, low connectivity between devices, and data-access issues. Although the Innovative Technology could improve current sustainability metrics by improving monitoring and operational efficiencies, the increased use of manufacturing sensors, Innovative Technology devices, and microprocessors means the processing of additional raw materials and the consumption of energy. While the environmental burden of the Innovative Technology may be insignificant compared to the positive effects it can bring, the widespread implementation of Innovative Technology devices in the circular economy demands its own lifecycle assessment to mitigate the consequent stress(Jabbour et al., 2018).

Hints to promote principle of repairs

There are many strategies to promote the adoption of the repair principle in a circular economy here are some of the strategies, Education and awareness campaigns Public campaigns can educate consumers about the benefits of repair, such as cost savings, product longevity, and environmental impact reduction. Repair services and infrastructure Businesses can offer repair services, and municipalities can invest in repair infrastructure, such as repair cafes and community repair workshops. Design for repair Manufacturers can design products with reparability in mind, using modular components, providing repair manuals, and offering spare parts.

Conclusion

The repair principle is a critical aspect of a circular economy, which aims to extend the life of products, reduce waste, and conserve resources. Promoting the repair principle in businesses can contribute to sustainable socio-economic growth and national development. To achieve these benefits, businesses can implement innovative technologies and best practices related to the repair principle. This includes digitization and automation of repair processes, development of modular and repairable product designs, and implementation of

sustainable procurement policies. By adopting these strategies, businesses can contribute to sustainable socio-economic growth, promote national development, and support the transition to a circular economy.

Suggestions For further studies

Empirical review should be carried out on principle of repairs, also Conceptual and Empirical reviews should be undertaken on other principles of circular Economy.

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CHALLENGES FACING THE LOGISTICS INDUSTRY IN MINNA

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ABSTRACT

This study explored the challenges facing the logistics industry in Minna, adopting a mixed-method approach through qualitative interviews and quantitative survey. A total of 80 respondents from eight major logistics industries participated in the survey, providing insights into their socioeconomic characteristics and perceptions of industry challenges. Findings revealed a significant consensus among the employees regarding the severity of the challenges, with a grand mean score of 3.83 and a standard deviation of 0.99. major challenges identified includes poor warehousing, insecurity, lack of integrated transport, unofficial contracts between drivers and customers, standardization gaps and communication issues. The study emphasized the critical need for comprehensive interventions to address these challenges and enhance the resilience of the logistics industry in Minna.

Keywords: Logistics, Challenges, supply chain

INTRODUCTION

As a result of globalisation and digitization, the logistics industry is seen as being crucial to facilitating more trade internationally (Mayer, 2018). Because the logistics industry facilitates the movement of commodities around the country, it is essential to the economic development and expansion of a nation. As a result of increased competition among nations, the logistics industry grows and becomes increasingly important to national economic development (Viswanadham&Gaonkar 2003). These days, logistics plays a significant part in commerce as it actively contributes to the nation's economic development. Reducing supply chain obstacles is therefore necessary if the economy is to maximise GDP and subsequently boost foreign commerce. (World Bank, 2013).

Organising, carrying out, and managing the flow of people and products inside businesses are all part of the supportive activity known as logistics. These endeavours aid and provide assistance in the supply chain procedure (Neubert et al., 2018). According to Sternad et al. (2018), these logistics-related activities foster knowledge, innovations, and fresh approaches to increase the company's profitability. Logistics service providers (LSPs) handle the

producers' logistical tasks so that their new items may be delivered to customers faster (Lai, 2004). The business enterprises engage in logistical tasks such as material management, processing strategy planning, and the archiving and retrieval of products information (Kherbash and Mocan, 2015). They tend to satisfy their needs for logistical services such as transportation, warehousing, and storage, distribution, sorting facilities, shipping, cargo handling, and inland waterways (Saksoft, 2018).

Mainly, logistics service providers (LSP) range from first-party logistics to fourth-party logistics (1PL-4PL). The LSP that falls under the 7PL category offers 4PL and third-party logistics (3PL or TPL) services. According to Sinkovics and Roath (2004), logistics is developing more asset-light and planning and design-oriented operations at the top LSP. According to Tipping and Kauschke(2016), economies of scale are shown by the effective logistics system. Logistics and transportation play a major role in the expansion of any economy. It is projected that the global logistics sector contributes four trillion US dollars in total. Between 8% and 20% of a nation's GDP is often attributed to logistics (GDP). 13% of India's GDP, or over USD 260 billion, is spent on logistics (Frank, 2018). Whereas, the logistics cost in the US is around 9%; the reduction in these logistics cost will lend a competitive advantage to Indian exports (Sharma and Kuswaha, 2017).

According to Kweka and Michael (2019), Nigeria gains a great deal from transit commerce, which has the ability to stimulate economic growth, welfare, and the expansion of local businesses. Arvis et al. (2007) state that logistics has grown to constitute a significant portion of the GDP of developed countries. As a result, it has an impact on a number of economic factors, including the availability and cost of energy, productivity, interest rates, and the rate of inflation. The interest in logistics has been fueled by the constantly shifting corporate environment brought about by outsourcing, lead time reductions, globalisation, and customer orientation (Hertz & Alfredsson, 2003). Logistics is a strategic source of competitive advantage, as evidenced by the rise in global production sharing, the shortening of product life cycles, and the intensifying worldwide rivalry (Arvis et al. 2007).

According to Doherty et al. (2013), the logistic sector's expansion will ease manufacturing and save distribution and transportation expenses. These days, logistics plays a significant part in commerce as it actively contributes to the nation's economic development. Therefore, in order to maximise GDP and therefore boost international commerce, the economy must

lower supply chain obstacles (World Bank, 2013). As a result, the advantages of the tariff reduction will lower logistics costs, which will raise GDP (Doherty et al. 2013).

In order to achieve the benefits of the logistics industry, it is important to ensure that logistics service is being provided as effectively and efficiently as possible. Minna, being a prominent center, relies heavily on the logistics sector to bridge the gap between producers and consumers, ensuring the timely and reliable distribution of goods. However, the industry faces a myriad of challenges that necessitates a nuanced examination. This study therefore assessed the challenges facing logistic industries in Minna, Niger State.

2.0. CONCEPTUAL FRAMEWORK

Logistic Companies (Logistics Services Provider) Providing the right quantity and quality of goods (or services) at the right place at the right time for the right client at the right cost is what the logistics process entails, which makes it integral to the supply chain management process. Over time, corporations have come to the realisation that outsourcing their logistics to organisations that are part of the supply chain—also referred to as logistic companies or logistic service providers—has shown to be more economical. An organisation that organises, manages, and controls the supply chain for another firm is known as a logistics company or logistics service provider. The logistics firm may function during the supplier acquisition, warehousing, shipping, order processing, and delivery stages, subject to the terms of the agreement made between the two parties.

Previous studies show that there are many examples of LSP categorization (Saglietto, 2013). Competency in logistics services is the most common dividing criterion. Lai's (2004) classification is a prominent example of this kind of division. Based on the operating service capabilities of each type of LSP, the author distinguished four distinct kinds. This includes full-service providers, transformers, conventional goods forwarders, and specialty markets. The ability of LSPs to resolve problems and modify their services to meet the needs of clients is another way to recognise them (Paczek, 2012).

Functions and Roles of Logistics Service Providers

Logistics service providers can work with several vendors to offer a one-stop shop for complex supply chain operations by using their knowledge and experience. A range of services provided by a third-party logistics provider save the client organisation from having

to hire a significant number of additional employees (Guidolin and Filha, 2022). When a 3PL manages a customer's supply chain, they can focus on their core competencies and grow from there. According to Ross (2015), logistic service providers carry out the following duties and functions, some of which are enumerated below:

- i. **Expertise/Knowledge:** From origin to distribution to final consumers, logistics service providers take care of all transit requirements. Experts possessing extensive knowledge of tariff schedules and customs legislation are highly skilled and capable of ensuring the most efficient and successful delivery route.
- ii. **Warehouse Management:** In order to optimise space utilisation and simplify warehouse requirements, service providers now help with warehousing budgeting, design, technology installation, and other activities. Inventory management services are one of the few things that these service providers are gradually providing.
- iii. **Documentation Services:** Without a doubt, unfettered product mobility is essential to the success of global trade. These companies help with company setup by handling all the documentation and legal requirements for conducting business abroad.
- iv. **Internet:** Logistic service providers help businesses enter new markets by using their well-positioned distribution networks. Given their extensive knowledge of the numerous laws and regulations governing these markets, these service providers might be able to provide guidance on viable economic marketplaces (Guidolin&Filha, 2022).
- v. **Value-Added Services:** Exporting is more practical when suppliers provide labelling and packing, for example. These vendors also share control and visibility over shipments and inventories through real-time tracking systems.
- vi. **Cutting costs:** By freeing up resources, delivering Turnkey solutions at a reasonable price, giving flexible, customised services, and much more, logistics service providers may demonstrate that they are cost-effective. To offer the company a comprehensive service package, they remove needless trade restrictions, determine the best tariffs, and extend shipment insurance (Guidolin&Filha, 2022). There is no denying that a firm can significantly cut

expenses and increase its ability to turn a profit by outsourcing supply chain operations to logistics service providers.

RESEARCH METHODOLOGY

The study was conducted in Minna and adopted a descriptive research design. Study was qualitative and quantitative in nature as questionnaires and interviews were adopted as method of data collection. A non-probability random sampling technique was adopted and the questionnaires were administered to 10 employees randomly selected from eight major logistics industries in Minna, making a total of 80 respondents. The questionnaire carried questions on socioeconomic characteristics of the employees as well as challenges facing the logistics industry in Minna. Questions were graded based on 5 pointlikert scales where 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree. The questionnaires were administered and collected after a week while interview were then conducted with the employees. The data collected were analysed using frequencies and mean statistics. Items with mean average above 2.5 signifies agree or high challenge while items with mean values below 2.5 signified low value and disagreement.

DATA PRESENTATION AND ANALYSIS

Table 1. Socio economic characteristics of Logistic Industry Employees

Variables	Frequencies	Percentages
Gender		
Male	48	60
Female	32	40
Total	80	100
Age		
18 – 30 years	22	27.5
31 – 40 years	33	41.3
41 – 50 years	15	18.8
51 – 60 years	5	6.3
Above 60 years	5	6.3

Total	80	100
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Marital Status

Single	33	41.2
Married	47	58.8
Total	80	100

Income level

Less than N50,000	68	85
N50,000 – N100,000	8	10
N100,001 – N150,000	4	5
N150,001-N200,000	0	0
Above N200,000	0	0
Total	80	100

Highest Level of Education

No formal education	0	0
Primary Education	0	0
Secondary Education	10	12.5
Graduate	67	83.8
Post Graduate	3	3.7
Total	80	100

Source: Author's Survey (2023)

From Table 1., it was revealed that 60% of the employees of the logistics industries studied were male while 40% were female. It was also revealed that 27.5% of the employees were between the ages of 18 – 30 years, 41.3% were between the ages of 31 – 40 years, 18.8% were between the ages of 41 – 50 years, 6.3% were between the ages of 50 – 60 years while 6.3% were above 60 years of age.

The result also revealed that 41.2% of the employees were single while 58.8% were married. The result also revealed that the 85% of the employees earned less than N50,000 monthly, 10% of the employees earned between N50,000 – N100,000, 5% of the users earned between N100,001 – N150,000. The result also revealed that 83.8% of the respondents held either Certificate of Education, National Diploma, Higher National Diploma or Bachelor's Degrees; 12.5% had secondary school certificates as their highest qualification, 3% had post graduate degrees.

The result also revealed that 57.5% of the employees studied had less than 5 years of experience working in the logistics industry, 32.5% had 5 – 9 years of experience, 5% had 10 -14 years of experience, 2.5% had 15 -19 years of experience while 2.5% had above 19 years of experience.

These findings suggest a male dominated workforce in the logistics industry in Minna with a significant proportion falling within the age range of 31 – 40 years. The high percentage of married employees suggests that family responsibilities may influence the demographics' work dynamics. The level of education underscores the importance of academic qualifications in this sector.

Understanding the implication of the distribution can aid in designing targeted training and development programs to harness the potential of both experienced and newer employees in the logistics industry.

Challenges Facing the Logistics Industries in Minna

The logistics industry in Minna is faced with several challenges ranging from unavailable or poor warehousing, multiple taxation and extortion, insecurity to lack of governmental support. An assessment of these challenges is presented in Table 2

Table 2. Challenges Faced by the Logistics Industries in Minna

Challenges	N	Minimum	Maximum	Mean	SD
Unavailable or Poor warehousing system	80	1	5	4.88	1.10
Bad road	80	1	5	3.91	0.95
Extortion on roads/ multiple taxation	80	1	5	4.15	1.16
Insecurity	80	1	5	4.83	1.12
Crude loading system	80	1	5	2.77	1.07
Lack of integrated transportation system	80	1	5	4.53	0.78
Unavailability of adequate vehicles	80	1	4	2.35	0.89
Poor communication/information sharing	80	1	5	3.65	1.02
Low Patronage	80	1	5	2.35	1.05
Unavailability of other transport modes as alternative for transportation	80	1	5	3.54	0.89
Lack of government support	80	1	5	4.78	0.98
Lack of standardization and regulation of practices	80	1	5	3.88	0.89
Unofficial contracts between drivers and customers	80	1	5	4.12	0.94
Grand Mean				3.83	0.99

Source: Author's Survey (2023)

Result from Table 4.6 shows that there are several challenges affecting the logistics industries in Minna. With a grand mean score of 3.83, the result shows that the challenges affecting the

logistics industry in Minna was high and was also recognised by majority of the employees as indicated by the standard deviation of 0.99. Some of the key challenges being unavailable or poor warehousing system with a mean score of 4.88, insecurity with mean score of 4.83, lack of integrated transport system with mean value of 4.53, unofficial contracts between drivers and customers with a mean value of 4.12, lack of government support with mean value of 4.78, lack of standardization and regulation with mean value of 3.88, poor communication/information sharing with mean score of 3.65, and lack of alternative transport mode with a mean score of 3.54.

Interview with the employees also shed more light on some of these challenges. Warehousing has been a major challenge especially due to the lack of capability in terms of technology and human resources. The process of arranging and processing goods are usually done manually and therefore results in mistakes, damage, more time consuming and stressful. Bad roads have also been identified to be a major barrier to smooth running of operation as it has resulted in accidents and delays over the years. Extortion and multiple taxations by supposed government personnel on the roads who charges the transporters heavily have also been a challenge, as this has even resulted in an increase to the cost of operation and charges.

Insecurity has also posed a major challenge, as areas and communities prone to attacks are most often abandoned in order to ensure the safety of the personnel and the goods to be transported. Attacks have also resulted in damages to commodities over the years and sometime have resulted in loss of live and goods. Backyard contracts between transporters and customers have also been noted to be a major challenge as efforts are continuously being made to curb the practice. Problems resulting from such transactions are usually outside the responsibility of the respective companies

These findings highlight significant challenges facing the logistics industry in Minna as reflected in the high grand mean score of 3.83 and a notable standard deviation of 0.99, indicating a consensus among respondents about the severity of these challenges. Key challenges such as unavailable or poor warehousing system, insecurity, lack of integrated transport, unofficial contracts between drivers and customers, lack of government support, lack of standardization, poor communication or information sharing all received substantial mean scores, underscoring their impact on the industry. This challenges therefore calls for a critical need for comprehensive and strategic interventions.

CONCLUSION

In conclusion, the study sheds light on the multifaceted challenges confronting the logistics industry in Minna. The high grand mean score and consensus among respondents underscore the urgent need for strategic interventions. The challenges identified including inadequate warehousing facilities, security concerns and gaps in government support, have tangible repercussions on operational effectiveness and cost. The study recommends targeted initiatives such as technological upgrades in warehousing, infrastructure improvements to address security and road conditions, and regulatory frameworks to mitigate unofficial transactions. Addressing these challenges comprehensively is crucial for the sustainable growth of the logistics industry in Minna, ensuring its resilience and contribution to the broader socioeconomic landscape.

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**DEVELOPMENT OF A USER-CONVENIENT WHEEL SPRAYERFRAME FOR
SMALL AND EXTENSIVE AGRICULTURAL APPLICATION.**

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ABSTRACT:

Many locally designed and fabricated mobile sprayers in Nigeria are discontent with user convenience and aesthetics. Consequently, they are confined as mere experimental studies, remote from responsive marketing potentials. This study thus presents the product development process of designing, physical mock-up model (PMM), simulation, and evaluation of a user-convenient operational frame, for wheel spraying machine, eligible for extensive operation and marketable in the targeted population. The frame innovative concept was developed by sketching the components, drawings, modeling in CAD, producing the components, and the PMM assembled following the design perimeters. Simulation on user-convenience analysis was carried out using real participants. The use of PMM in simulation was to validate the design before actual fabrication. Variations in participants including height, grip size, age, and gender were considered alongside convenience factors. Data collection tools included Semantic Differential Question to obtain data on how participants rate their experience of the PMM. A video camera was used to obtain visual data and analyze how participants handled the frame. The user-convenience evaluation mean indicated that 71.42% had a less stress after 15 minutes of simulation. This shows that the developed frame reduced discontent, will enhance extensive operation and increase marketing potential.

Keywords: Frame, Mock-up, user-convenience, product development, mobile-sprayer.

1. INTRODUCTION

Creative design thinking is cardinal in the process of developing ideas into working, novel, commercial innovative products. It is evident that the product development (PD) process, emanating from creative design thinking, substantially enhanced user-convenient and marketable products. Mechanical or electrically human operated equipment which were developed following this process are convenient to use, visually appealing and more marketable.

A sprayer is a mechanical equipment used to spray liquids like herbicides, pesticides, fungicides, and fertilizers to the crops to prevent pests or insects from destroying the crops, and enhancing yield. Kurniawan, (2020) assert that the sprayer is a system created to convert liquids into mist or solution. Sprayer provides optimum utilization of pesticides or any other chemicals with minimum efforts and less cost. Farmers use knapsacks, hand or fuel operated

sprayers to perform this task. This traditional spraying method causes user fatigue due to excessive bulky and heavy construction (Arunkumar M., 2015). The development of wheel spraying machines doubtless, enhance spraying experience and consequently improve crop production. This has prompted many product designers in various fields of study to explore the design and further development of the sprayer, following current technologies in field sprayers (Alsebiey, et al. 2022). Field Sprayer Technology aiming to address various problems perceived in order to improve spraying experiences. Yet, many designers of wheel sprayers pay more attention to source of power to drive the equipment, liquid carrying capacity and boom sprayer. Such improvements engender extensive pushing and operation.

Previously known locally produced wheel sprayers were basically developed aside of creative design thinking, industrial design PD process. As such, attention would have not been given to specific factors of user convenience, especially the handle. More so, appealing form to attract customer and enhance marketability, was unconsidered. One of the pit holes of locally produced machinery is inconsideration of human factor in the product developed.

Human factors and ergonomics (HF/E) Acosta *et al.* (2011) is concerned with the design of products, process, services and machinery to enhance productivity and user satisfaction, and Gomes (2021) refers to the end user, as the 'human factor'. By understanding the limitation or human body dynamics and behavior, products can be developed that are effective, comfortable and safe for use (Ahram & Jang, 2018).

It is evident that research is increasing in new digital technologies such as industry 4.0 where automated machines perform the task. Yet, it is mostly common in the developed countries, whereas in a developing country such as Nigeria, manual operated equipment remain relevant and are being developed for extensive operation. This has evoked the need for safety, user-convenience, and for competitive marketability of the wheel sprayer. Thus, style, form or aesthetics need to be considered as required by principle of 'good design'. The developed sprayer handle in this study is from an industrial design approach, evoked by creative design.

2. PURPOSE OF THE STUDY

The project aimed to design, produce, fabricate and test operation convenience of frame for wheel sprayer.

The objectives of the project were to:

- i) Creatively design a user-convenient frame for mobile sprayer equipment that would be aesthetically appealing.
- ii) Produce and test the frame
- iii) Evaluate convenience

3. LITERATURE REVIEW

Significant research has been conducted on innovative designs on shape of equipment to improve experience of operation. James Dyson 1974 invented the Ballbarrow to improve the pushing experience. Dyson's experience of using a conventional barrow whose wheel sunk into soft surfaces, evoked his research and outcome. Similarly, Godilano *et al* (2018, April) designed a wheelbarrow to reduce physical demands on the user, following the process of ergonomics.

Kadir *et al* (2019), conducted a study on the relationship between HF and ergonomics, through a systematic review, outlined the benefits of considering HF/ E in developing work facility.

Relatively, much has been written on creativity and innovation, Roy & Group (1993) examined case studies of creativity in innovative product development. Roy (2024) in creative design and innovation, carried out an analysis of different factors to help foster creativity, enable creative ideas to be converted into real new products on the market. Furthermore, concept of creative design has been discussed by various scholars. Logan, & Smithers (1993) outlined design problems, the objective to be achieved, and the means of achieving it. Cooper (2019) outlines challenges of PD to include speed of globalization and ambiguities. Whereas clients emphasize the cost of production, the end-user considers the functionality, while the industrial designer concedes to the methodology and process, his focus is on making the design good.

Ergonomics processes were reviewed in order to produce a user-convenient product. Relevant literature review, including Benoset *al.* (2020) indicate that poor ergonomics on a product could be harmful to human. It was observed that when ergonomics is incorporated into PD, it improves efficiency, safety, and productivity.

The status physical mock-up in similar study is reviewed in a recent study of physical ergonomic testing for the design of an innovative mail delivery vehicle, published in Journal of Ergonomics, Rogeretal(2018) explored physical mock-up in testing, evaluation and

generating data towards ergonomics of the mail delivery vehicle. They submitted that physical mock-up has the potentials to provide proper dimensions in product development, considering ergonomics.

The theory of PD starts with identification of the problem, then improvement of a product in terms of its functionality, ergonomics, aesthetics, and cost benefits (Alli,2018).Meganathan et al. (2018) conducted a study specific to design and fabrication of mechanical pesticide sprayer. Findings were from engineering perspective. However, findings from review also show that the general design process follows a guideline involving three main sections including analysis, concept, and synthesis putting ergonomics in perspective as outlined in the table below:

Table 1: Ergonomic design process requirement.

Design Process	Involvement	Step
Analysis	Accept situation	This is when the designer decides on committing to the project and finding a solution.
	Analyze	In this stage, everyone in the team begins research.
Concept	Defining	is where the key issue is defined, the conditions of the problem become objective
Synthesis	Ideate	At this point, the designer brainstorms different ideas, solutions for their design problem.
	Select	Selection from the wide range of ideas a few options, with potentials to succeed
	Implement	Prototypes are built at this stage and plans are outlined for actual production.

Evaluate The products are tested and improvements are made. That does not mean the process is over, adjustments may be required.

4. MATERIALS AND METHODS

4.1 Materials and Specifications

Material schedule: In order to carry out experiments in this research, and consequently assemble the physical mock-up, and actual product, the below mentioned materials were sourced by construction, rented, service request or procurement. However, most of the materials were procured.

Table 2. Material schedule.

S/N	MATERIAL	SPECIFICATION	DIMENSION	QUATITY
1.	Timber	Obeche, lightweight	152 inches	1
2.	Bearings	standard imperial	3inchs	2
3.	Wheel/ Tires	Bicycle	24 inches	2
4.	Screws	Countersunk head, slotted wood screw	4.5 inches	20
5.	File/ grinding machine	-	-	1
6.	Steel pipes	(a) hollowed rectangular hollowed rounded	3.5 inches x 12	3
7.	Welding equipment		-	1
8.	Measuring equipment	a) Tape b) Flexible rope	-	1

Source: Researcher, 2024

4.2 Methods

The participant observational method which is a form of qualitative observation research, a qualitative research technique was used, as discussed in Qaddo(2019). Participants are usually observed on ongoing behavior in a natural setting. In addition, review of selected locally developed wheel sprayers was carried out. More so, construction of an actual frame was done.

The applied method used included observation of user of a wheel sprayer during a field study. In addition, personal interaction with a locally fabricated wheel sprayer also provided insight. Some locally designed wheel sprayers were reviewed to know if convenience of user was well considered. Product development (PD), and ergonomics theories were critically reviewed to guide the process in this research.

Relevant materials were obtained locally by purchase. Wood shaping and fabrication equipment were sourced from local workshops. Steel was selected for the frame because of its strength, light weight and good weldability. While obeche wood was selected for its great strength, light weight and can be conveniently shaped according to design specification. Hand size of 7 participants was measured using measuring tape. The circumference of their hand was measured using a flexible thread. The thread was placed round the palm, then stretched on a measuring ruler and figures were recorded. This enabled specific shaping of the handle grip. Respondents included 4 males and 3 females of different ages.

Many sketches, and drawings were initially produced to generate the working concept. Graphical modeling tools, including CAD software were used to develop the design, and a CAD model produced. A physical mock-up model was created to use in testing. Research ethical issue regarding consent of user and participants below 18 years was considered.

4.2.1 Design consideration and perimeters

Hand size is a critical factor in the handle grip design. The handle grip is significant to user-convenient, was designed using CAD software. It is established that hand sizes vary according to various factors, including gender, age and height. Males tend to have larger hands than females. The design specified the handle grip shape, to suit various hand sizes based on variables in this study, and to contain operation switches. Figure for handle grip were. The frame dimensions were provided.

The grip size was determined after careful consideration. The user-convenient wheel sprayer frame final design was developed after extensive review of other locally developed models, related studies and ergonomic factors. As a result, the perimeters and handle grip shape developed was precise for this project. The mock-up model was constructed using wood, and was used to physically test the product objective.

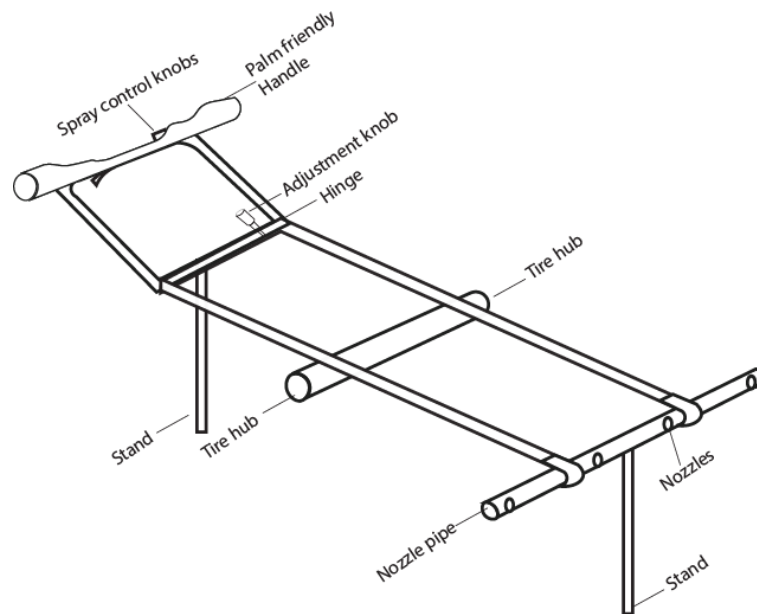


Figure 1: Drawing showing parts of the wheel

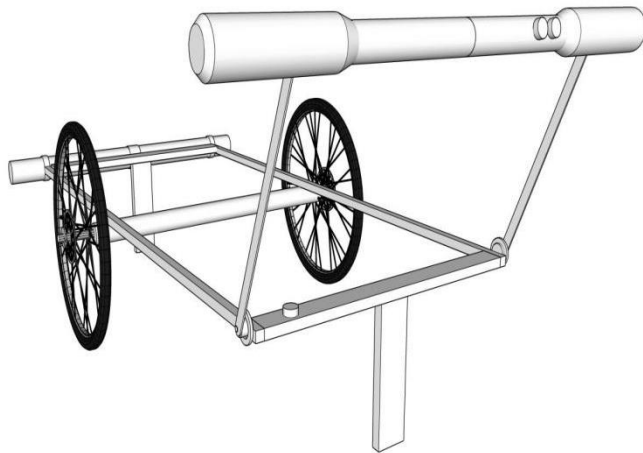


Figure 2: CAD model of the wheel sprayer

4.2.2 Testing comfortability and attractiveness of the frame

Semantic Differential Scale was used to collect data to measure the opinion of respondents towards the developed handle and frame, based on the interaction of the participants with the physical Mock-up Model. Two sets of data were collected:

- i. Evaluative semantic differential scale: respondents were asked to rate their experience of the handle grip on the level 'comfortable - 'uncomfortable'.
- ii. Evaluation of frame attribute semantic differential scale: to measure the perception of the frame style attribute, respondents were asked to rate the frame on basis of its attractive level as 'appealing' or 'repulsive'. The gathered data was reviewed and analyzed.

4.3 Participants

Seven (7) participants were voluntarily involved. Ethical issues regarding such a research were considered. Respondents included 4 males and 3 females of different ages. The respondents were selected based on previous experience with other sprayer equipment. The criteria used to measure participants hand size in this research were:

- Length (L): distance from the wrist to the tip of the longest finger.
- Breadth (B): measurement across the widest part of the hand.

- Circumference (C): measurement around the palm.
- Gender: Male (M) or Female (F)

Table 3. Respondents' data.

Respondent	Age (years)	Height	Palm (L)	Palm (B)	Palm (C)
Gender		(Feet)	inches	inches	inches
1. M	43	6.1	7.5	3.4	8.5
2. M	27	5.6	8.1	3.7	8.7
3. M	19	5.7	7.2	3.3	8.3
4. M	13	5.0	6.6	3.0	7.4
5. F	28	5.7	6.8	3.1	7.0
6. F	22	5.9	6.5	3.0	7.2
7. F	13	4.9	5.8	3.0	6.9

Source: Dese Dzenda, 2024

4.3.1 Construction

Construction of the frame included welding, grinding/ filing, of the metal materials. Drilling and assembling of composites, followed according to the design specification. The construction was performed at the workshop. While drilling action on the frame is to prepare for electrical composites and for the sprayer control switch and pressure regulator to be connected to the compressor and battery appropriately.

5. RESULT AND DISCUSSION

Data for the user convenience of the frame was obtained from 15 minutes of simulation with the frame by 7 respondents. It was observed that for a taller user to move faster during operation, outwards adjustment of the handle was required, for ultimate comfort.

5.1 Results

Table 4. Responses on handle grip.

	Item	Comfortable	Uncomfortable	Neutral
1.	Handle grip	6	1	0
2.	Pushing	5	0	2
3.	Extensive use	4	0	3

Source: Dese Dzenda, 2024

Table 5. Responses on style

	Part	Appealing	Repulsive	Neutral
1.	Shape	6	0	1
2.	Size	5	1	1
3.	Material	7	0	0

Source: Dese Dzenda, 2024

Discussions

Analysis from evaluative scale in table 4 above show that 85.71% were comfortable with the handle, while 14.28 % were uncomfortable with the grip. 71.42% were comfortable with pushing the frame, whereas, 28.57% were neutral. In extensive use of the frame, 57.14% agreed on its overall comfort for extensive operation. Whereas, in the evaluation of frame in table 5 above, 85.71% indicated that the shape was appealing to their eyes, while 14.28% remained neutral. 71.42% admired the size, while 14.28% despised it and 14.28% were not sure. However, all the respondents, 100%, admired the material used in developing the frame.

To have a mean of user-convenient in simple arithmetic, the formula $\bar{x} = \sum x/n$ was used as follows:

Comfortability of frame (CF) = percentages of handle grip (HG) + pushing (P) + extensive use (EU) /3.

$$CF = HG(85.71) + P(71.42) + EU(57.14) = 214.27$$

$$CF = 71.42\%.$$

For the purpose of improving spraying experience using wheel sprayer, 3 locally fabricated wheel sprayers were reviewed. This led to focus on the grip handle and frame perimeters. Many initial conceptual drawings were produced and consequently developed into design. A physical mock up prototype was then produced following the design indicated in figure 2 above. From the test carried out, respondent 1, as show in table 1 above, with age 43, agreed that the handle grip was convenient at the end points of the handle, while the frame handle was comfortable at 4.4 feet, given his tall height. On the other hand, respondent 7, aged 13 with a smaller grip size agreed that the grip handle was more convenient at the middle of the grip handle and comfortable at 3.4 feet high.

6. CONCLUSION AND RECOMMENDATION

In the analysis, a careful review was carried out regarding factors considered in developing the grip handle for a wheel sprayer targeted for extensive agricultural application, and aesthetically appealing to user. Following that, major ergonomics factors pertaining grip and push frame for wheel sprayer were gathered. Ergonomic design process, as outlined in Acosta *et al.* (2011) and shown in table 1 above, and PD theory were applied.

Definitely, convenience of user is important for extensive operation of the wheel sprayer. Although challenges of cost, creative design professionals, technology aspects as opined by Benos, *et al.*, (2020) deter quality product development. Yet, safety issues, human health and aesthetics are still important fields for developing agricultural products and enhancing their marketability. In developing wheel sprayers, human is central even for the locally fabricated. Adjustment consideration to enhance comfortability of user is imperative for prospective wheel sprayer machine.

6.1 Conclusion

The research argued the need to enhance user convenience in wheel sprayer. The study led to the design of a grip handle, adjustable frame and eye-appealing wheel sprayer machine. Creativity was significantly involved in the innovative design.

The primary limitation of this research, however, is that test for marketability of the product was excluded. This could have generated data for product development in local environments, however, the creativity involved and the quality of materials used redresses the expected. Product developers and designers who follow the method in this study will produce not just a user-comfortable attractive wheel sprayer frame, but other physically operated products as well.

6.2 Recommendation

- i. Developers of human physically operated products, such as wheel sprayer, are encouraged to always apply ergonomics processes. This would enhance safety, and user-comfortability of the product, thus, will improve well-being of the user.
- ii. There is need to consider aesthetics, and styling in product development. This would make the product appealing, and will enhance its marketability.

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BARRIERS TO ADOPTION OF LEAN CONSTRUCTION PRINCIPLES IN BAUCHI METROPOLIS, NIGERIA¹Filibus Ibrahim Danfitoh²Ibrahim Ibrahim Inuwa, ³Musa Muhammed Mukhtar¹Department of Quantity Surveying, Federal Polytechnic, Bauchi, Nigeria-West Africa.^{2&3}Department of Quantity Surveying, Abubakar Tafawa Balewa University, Bauchi, Nigeria-West AfricaEmail: ifilibus@fptb.edu.ng**ABSTRACT**

Lean concept originates from the manufacturing industry, and it is concern with minimizing waste and maximizing values by removing non-value-adding activities during building production thereby, enhancing performance and waste reduction. Waste generated by the construction industry activities has cause danger to both the construction projects concerned and the environment at large. The study investigates the barriers to successful adoption of lean construction in the Nigerian construction industry. The study used exploratory and descriptive designs with literature review and questionnaire survey respectively. From a population of 170 construction professionals gotten from projects in higher institutions within Bauchi, 118 respondents' questionnaires were conveniently administered to construction professionals in Bauchi metropolis, Nigeria. The survey records a valid response rate of 69.49%. Afterwards descriptive method of analysis was used to analyzed the data obtained from the survey. Findings revealed that Corruption (unethical professional behavior), lack of long-term commitment to change and innovation, lack of interest from clients were the most severe barriers. It was recommended that construction professionals to eschew Unethical professional practice (corruption) in the discharge of their duties and create more awareness of lean construction principles and its potential benefits through education and training.

Keywords:Lean construction; Lean principles; Barriers,Construction project.**1.0 INTRUCTION**

The adoption of the new production philosophy known as Lean Production in the manufacturing industry in the past few decades rewarded the industry with a great performance improvement through an increase in workers' productivity(Agyekum, 2012). The concept provides a suitable way for minimizing waste and maximizing values while removing non-value-adding events during building production (Sols, 2018). Li et al. (2019) reported that the similarity and commonality between construction and manufacturing provides a basis for lean concept to be introduced to solve problems related to non-value-adding activities in the country industry. Lean construction is a novel approach which has rapidly grown in recent years (Monyane et al., 2020; Shang & Sui Pheng, 2014).

Studies have shown that in spite of the enormous benefits of lean construction (LC) practices which bring about cost and time savings, better safety performance records, reduction of errors and rework, improved quality and waste reduction, better predictability of work,

improved productivity, enhanced inventory management, and improved client satisfaction, the adoption of the concept is not fully embraced in the industry globally (Farrar et al., 2004; Ko, 2010; Mohan & Iyer, 2005; Salem et al., 2006). Albalkhy and Sweis (2020) acknowledged that LC adoption in some developing economies is low and this could be as a result of either not adequately known or fully welcomed. Similarly in Nigeria, the LC is not implemented on a full scale, and maximizing the full benefits of lean has continued to be an illusion. Construction organizations are reluctant to fully implement LC techniques which have proved to be an innovative solution to construction projects' performance problems (Nwaki & Eze, 2020). Howell (1999) asserted that the adoption of lean production approach in the construction industry will curtail waste through activity centred thinking and improve project performance through the reduction of cost and duration of each construction activity.

Construction projects material wastage is a global menace which the construction industry is struggling to curtail. Construction activities in the US generates about 29% of landfill waste (Yu *et al.*, 2013), while the industry landfills about 40% in Brazil, Australia 44%, Canada 27% and 25%, in Hong Kong respectively (Yeheyiset *et al.*, 2013; Lu & Tam, 2013; Oyedele *et al.*, 2014). Osmani (2011) established that 10% of the materials delivered to sites in the United Kingdom (UK) construction industry end up as waste that may not be accounted for. Moreover, Ameh and Itodo (2013) reported that, in the UK, material waste accounts for an additional 15%, to construction project cost overruns and for 11% in Hong Kong. Similarly, between 20% and 30% cost overrun of as a result of construction-material wastage in Netherlands. This constraint negatively affects the delivery of many projects (Adewuyi & Oтали, 2013). Furthermore, Adewuyi and Oтали (2013) argue that the quantity of material waste generated on some construction sites exceeds, to some extent, the 5% allowance made to take care of material wastage while preparing an estimate for a project.

Similarly, in Nigeria, waste in the construction industry is a well-known problem that seems not to be given the recognition it deserves (Babatunde, 2012). One of such problem is reported by Ameh and Itodo (2013) that for every 100 houses built, there is sufficient waste material to build another 10 houses in Nigeria. In this vein other studies noted that material wastage has become a serious problem, and therefore requires urgent attention in the Nigerian construction industry (Amade, Ononuju, Obodoh, & Okorie, 2019).

The Nigerian construction industry suffers from inefficiency with low productivity and lack of capacity to deliver and satisfy its clients. This is evident in the drop in the Nigerian construction industry 's contribution to GDP between 2015 to 2020 to poor performance and low productivity(WorldBank, 2020). The concept of lean construction offers itself as a tool for performance enhancement in the construction industry. In this light this study sought to investigate the barriers to the adoption of lean construction principles in Bauchi town, Nigeria.

2.0 LITERATURE REVIEW

2.1 The Concepts of Lean in Construction Project

Lean construction has its origin in the manufacturing industry, it was developed by Toyota production system in the 1950s led by Engineer Ohno who was committed to eliminating waste (Howell, 1999; Bajjou&Chafi, 2018; J. G. Sarhan et al., 2017). As a results of the successes and benefit recorded in manufacturing sector from adoption of the lean concept has trigger the subsequent application of the lean philosophy in construction industry. Koskela (1992) was one of the pioneer authors who tried to introduce lean thinking in the construction industry. The applicability of what was called “the new production philosophy” is contained in the Stanford report produced by the author. According to Omotayo and Kulatunga (2014), after Toyota motors first introduced the lean concept to manufacturing, it has successfully been applied in the construction industry globally.

Koskela and Howell (2002)defined lean construction as a way of designing production systems to minimize waste of materials, time, and effort in order to generate the maximum possible amount of value. It is a holistic design and delivery philosophy with an all-encompassing aim of maximizing value to all stakeholders through systematic, and continuous improvements in the contractual arrangements, product design and method of selection, the supply chain and the workflow reliability of site operations. Its underlying principle is to eliminate/avoid all categories of waste; be it time, space, human resources or materials that do not contribute to the value and quality of finished products (Ajayi, 2017). Therefore, waste minimization and value maximization are the main philosophy of lean in the manufacturing. According to Manrodt et al. (2008), LC adopts a systematic approach for enhancing value for clients by identifying and eliminating wastes through iteration of

processes for continuous improvement in the pursuit of excellence. Flowing from the aforementioned, LC is aimed at ensuring that the management of construction projects focuses on the minimization of waste and maximization of values for clients and project success. The core concept behind LC is to enable the flow of value creating work steps while eliminating non-value steps i.e., waste by focusing on fast cycle times. When waste is removed from the construction process, cycle times drop until physical limits are reached.

2. 2 Lean Construction Principles and Techniques

Lean construction has principles several tools and techniques that have evolved since the beginning of its application in the construction industry (Abdelrazig, 2015). These tools and techniques continue to develop as more understanding and experience develops. Lean construction has been identified as ways of developing a list of the most prominent and exhaustive tools and techniques that are being implemented in today's construction industry and that might also impact performance practices (Forbes and Ahmed, 2011). Howell, (1999) highlighted some of the tools as [Constraint analysis, look-ahead planning, the Percent Plan Complete (PPC) measurement, concurrent engineering, just-in-time, resources managing, immediate problem detection, standardization, detection of incompatibility and discrepancy, process evaluation, team integration, use of visual indicators and continuous improvement]. The implementation of such lean tools and techniques had significantly reduced waste and improved performance in construction projects (Abdelrazig, 2015).

“Lean” is essentially about getting the right things to the right place at the right time, in the right quantity whilst minimizing waste and being open and responsive to change (Kempton, 2006). Lean production has an underlying philosophy that, by eliminating waste, quality can be improved, and production times and costs reduced (Kempton, 2006). In order to reduce waste, a set of key manufacturing principles should be employed as thus: Perfect first-time quality: achieving zero defects, revealing and solving problems at the source. Continuous improvement: reduction of costs, increase quality and productivity. Waste minimization: eliminating all non-value adding activities and maximizing the use of resources. Keeping everything simple, right from design through to completion. Increasing output flexibility: thus, the production of different mixes and or greater diversity of products, without compromising efficiency.

The principles were further simplified by (Agyekum, 2012) to suite construction industry as follows: Delivering what the client wants, Establishing continuous improvement: thus, reduction of costs, increase in quality and productivity, Doing the right things at the first time: thus achieve zero defects, revealing and solving problems at the source, Avoiding defects in the works done that can result in for example, waste, unnecessary rework, loss of customers and corporate reputation. Involving the whole project team through the design to construction, Constantly seeking better ways to do things, Increasing output value through systematic consideration of customer requirements, Increasing output flexibility: thus, the production of different mixes and/ or greater diversity of products, without compromising efficiency, Waste minimization: thus, eliminating all non-value adding activities and maximizing the use of all resources, Building and maintaining long-term relationships with suppliers

2.3 Barriers to Lean Construction adoption

Lean construction has proved to be a highly rewarding venture to the construction industry in the UK (Sarhan & Fox, 2013). Sarhan and Fox (2013) further opined that this assertion was emphasized by the Egan's Committee who equally stated that the concept of lean thinking could lead the UK construction industry's quest of improving quality and efficiency. A good number of barriers militating against the successful implementation of lean abound in the literature, they include Sri Lanka (Senaratne & Wijesiri, 2008), Uganda (Alinaitwe, 2009), China (Gao & Low, 2014), Indonesia (Abduh & Roza, 2006) and Nigeria (Olatunji, 2008).

Research has been carried out with a view to investigating the factors that could impede the successful implementation of lean construction, notable amongst them are highlighted below even though from the available literatures, there are no studies relating to the aforementioned issue that has been carried out in Nigeria specifically.

The application of lean principles to construction is bound to encounter some obstacles. A study by Ayarkwa et al. (2012a) identified and prioritized possible barriers to the successful implementation of lean construction in the Ghanaian building industry and measures to overcome potential barriers. The study identified the barriers to include lack of proper planning and control, lack of teamwork, poor project management, lack of technical capabilities, lack of financial resources and poor communication between parties.

Bashir et al. (2010) in a study on barriers towards the sustainable implementation of lean construction in the UK construction organizations found six barriers categorized based on a thorough and critical review of literature relating to lean practices. The barriers identified include; financial, educational, governmental, attitudinal, managerial and technical issues.

Sarhan and Fox (2013) in its study, sought to identify and assess the possible barriers to the successful implementation of Lean in the UK. Based on an extensive literature review, followed by a statistical analysis of data gained from a questionnaire survey which targeted practitioners in the UK construction industry, a number of barriers were identified as key. The barriers include; lack of adequate lean awareness and understanding; lack of top management commitment and cultural and human attitudinal issues.

Barriers to lean implementation according to Tourki (2010) vary from one firm to another based on the aims and objectives, and firm types. Tourki (2010) further grouped these barriers into four categories namely; technological barriers, financial barriers, external barriers and internal barriers.

Ogunbiyi (2014) in a study on the implementation of lean approach in sustainable construction in the U.K., identified the following as key barriers to lean implementation. They include; resistance to change and culture; employees 'attitudinal issue; lack of management support; lack of customer-focused and process-based performance measurement systems; lack of adequate lean awareness and understanding; and lack of implementation understanding and concepts are some of the most severe barriers to the implementation of lean.

Table 1 Barriers to the Adoption of Lean Construction

S/N	BARRIERS TO THE ADOPTION OF LEAN CONSTRUCTION	SOURCE(S)
1	Lack of interest from clients	Agyekum (2012)
2	Waste accepted as inevitable	Agyekum (2012)
3	Lack of adequate lean awareness and understanding	Ogunbiyi (2014)
4	Lack of training	Ayarkwa et al.

		(2012a)
5	Government bureaucracy	Olatunji (2008)
6	Delays in decision making	Ogunbiyi (2014)
7	Lack of top management support and commitment	Ogunbiyi (2014)
8	Misconceptions about lean practice	Olatunji (2008)
9	Seen as too complex and alien	Agyekum (2012)
10	Fear of unfamiliar practices	Ogunbiyi (2014)
11	Unsuitable organizational structure	Senaratne&Wijesiri, 2008
12	Poor communication	Ayarkwa et al. (2012a)
13	Difficulty in understanding concepts	Olatunji (2008)
14	Inconsistency in government policies	Alinaitwe, 2009
15	Inadequate pre-planning	Ayarkwa et al. (2012a)
16	Lack of client and supplier involvement	Agyekum (2012)
17	Corruption	Olatunji (2008)
18	Lack of long-term commitment to change and innovation	Ogunbiyi (2014)
19	Poor procurement selection strategies	Olatunji (2008)
20	Lack of technical skills	Olatunji (2008)
21	Inadequate exposure to requirements for lean adoption	Alinaitwe, 2009
22	Lack of long-term relationship with suppliers	Gao & Low, 2014
23	The fragmented nature of the construction industry	Senaratne&Wijesiri, 2008

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- | | | |
|----|---|--|
| 24 | Lack of holistic implementation | Olatunji (2008),
Sarhan& Fox (2013) |
| 25 | Incomplete designs | Gao & Low, 2014 |
| 26 | High dependency of design specifications on in-situ materials and components rather than standardized and industrialized prefabricated components | Alinaitwe, 2009 |
| 27 | Extensive use of subcontractors | Olatunji (2008),
Sarhan& Fox (2013) |
| 28 | Lack of agreed implementation methodology | Olatunji (2008) |
| 29 | High level of illiteracy | Olatunji (2008) |
| 30 | Poorly defined individual responsibilities | Ogunbiyi (2014) |
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3.0 METHODOLOGY

The study was conducted in Bauchi metropolis, which is the administrative capital of Bauchi State. The State is located in the North-eastern zone of Nigeria. The study adopted quantitative design using exploratory and descriptive approach. (McNabb, 2009) The questionnaire survey was adapted to get feedback on opinions of respondents about barriers to the adoption of lean construction principles in the construction process in Bauchi metropolis. this study explore literature on concept of lean construction to identify lean construction principles and the barriers to adoption lean construction principles in construction industry. Literature reviewed was used to design a questionnaire so as to get opinion of Professionals. Data collected from field through the structured questionnaire were analysed using both descriptive and statistics. Descriptive statistics concern with the development of certain indices from the raw data (Kothari & Garg 2014), Frequencies, percentages and formulas were used as descriptive statistics tool, Descriptive statistics (frequency and percentage) was used in the analysis of the qualitative data as well. The

population for this study comprised of architects, quantity surveyors, builder, project managers and site supervisors working on TETFund sponsored projects located in Federal Polytechnic Bauchi (FPTB), Abubakar Tafawa balewa University Bauchi (ATBU), and AbubakarTatari Ali Polytechnic Bauchi. (ATAP). The study arrived at a sample size of 118 respondents from a sample frame of 170 respondents using Krejcie and Morgan (1970) Table. The study adopted convenience sampling technique. This sampling technique enables the study to administer questionnaires to respondents that are available at the time of conducting the study. A total of 82 valid questionnaires were returned which is 69.49% response rate.

The structure questionnaire is made up of two (2) sections: Section A captured demographic background of respondents seeks respondents' information on their level of education, professional specialization. The Section used a close ended question. While sections B employed a 5-point Likert Rank Scale: 5- Extremely Severe (ES); 4 - Severe (SE); 3 - Moderately Severe (MS); 2 - Least Severe (LS); 1 - Not Severe (NS). were employed to evaluation respondent's opinion on barriers to adoption of lean construction principles in Bauchi, which enquired information on their severity. Closed-ended questions was used. The study collected data from primary and secondary sources respectively. Data were analysed using severity index to rank the variables' level of severity. Data used for this study were qualitative and quantitative. The data were obtained from literature review and questionnaire responses respectively. The quantitative data were analysed using descriptive statistics. Percentage and frequency were used to analyse the demographic profile because they are categorical data used to assign identity,

4.0 RESULTS AND DISCUSSION

4.1 Questionnaire Administration

The study administered 118 questionnaires to the study respondents in the order shown in table 2. The distribution yielded 82 valid responses representing 69.49% response rate. This response rate for this type of survey is higher than other studies carried out in the construction industry. For instance, Usman, et al. (2012) recorded a response rate of 55.25%, Iro, et al. (2013) received a 55.25% response rate.

Table 2: Questionnaire response rate

Respondents	Distribution	Returned	% Response Rate
Architect	30	24	20.34
Builder	20	10	8.47
Project Manager	21	12	10.17
Quantity Surveyor	22	16	13.56
Site Supervisor	25	20	16.95
Total	118	82	69.49

4.2 Respondents Working Experience

Table 3 also shows the demographic information of the respondents working of experience 31.7% have 0 to 5 years working experience, 31.7% have 5-10 years working experience; 22% have 11-15 years working experience, about 10% with 16-20 years working experience and about 5% have above 20 years. This indicates that the respondents have enough working experience as construction professionals to respond to the questions. The level of education of the respondents also indicated that more than 70% of the respondents have more than five years of working experience, which signifies that the respondents have good experience and are also in a position to answer the questions.

Table 3: Working Experience of Respondents

Years	Frequency	Percent	Cumulative
0 -5years	26	31.7	31.7
6 -10years	26	31.7	63.4
11 -15years	18	22.0	85.4
16 -20years	8	9.8	95.1
Above 20years	4	4.9	100.0
Total	82	100.0	

4.3 Barriers to Lean Construction adoption

The result in table 4 below shows that the average severity index of Barriers to the Adoption of Lean Construction 0.724. However, corruption (unethical professional behaviour) with severity index of 0.846 was rank the most severe barrier to adoption of lean construction. While Lack of long-term commitment to change and innovation, Lack of interest from clients, Lack of adequate lean awareness and understanding, Lack of holistic implementation and Inadequate exposure to requirements for lean adoption among others were the severe barriers encountered with severity indices of 0.783, 0.781, 0.776, 0.761 and 0.751 respectively.

Table 4 shows that corruption (unethical professional behaviour), Lack of long-term commitment to change and innovation, Lack of interest from clients, Lack of adequate lean awareness and understanding and Lack of holistic implementation were ranked 1st, 2nd, 3rd, 4th & 5th with severity indices of 0.846, 0.783, 0.781, 0.776, 0.761 and 0.751 respectively. This reflects that corruption, Lack of long-term commitment to change and innovation, Lack of interest from clients, Lack of adequate lean awareness and understanding and Lack of holistic implementation are the main barriers for the adoption of lean construction principles in Bauchi metropolis -Nigerian construction industry. The study conducted by the Aigbavbo et al., (2016) in South Africa and Laisha, et al., (2019) in Nigeria agreed with the findings that the followings are barriers to lean construction principles, :Corruption, lack of interest from client and supplier involvement, poor communication, Inadequate pre-planning, human attitude towards change, fragmentation nature of the industry, lack of top management support and commitment, and lack of training. Alinaitwe (2009) further supported the result by highlighted the followings as barrier associated with the lean construction, lack of communication, lack of projects team skills and lack of defined focus for the team, human attitude towards change. In addition, the result shows that inadequate exposure to requirements for lean adoption, incomplete design, lack of technical skills, poor communication, inconsistency in government policies and lack of top management support and commitment. were ranked 6th, 7th, 8th, 9th, 10th, 11th & 12th with severity index of mean scores of 0.751, 0.751, 0.737, 0.734, 0.729, 0.727 & 0.724, respectively. This signifies that the aforementioned are the leading barriers for the adoption of lean construction principles in Nigerian construction industry. Except adequate efforts are made to overcome these barriers, several companies could be discouraged from adopting lean in their

organizations. The result further shows: Government bureaucracy, Seen as too complex and alien, Unsuitable organizational structure, The fragmented nature of the construction industry, Waste accepted as inevitable & Inadequate pre-planning were ranked 18th, 19th, 20th, 21th, & 22th with severity index of: 0.685, 0.673, 0.673, 0.673 respectively. This indicates that Government bureaucracy, seen lean construction as too complex and alien, Unsuitable organizational structure, The fragmented nature of the construction industry, Waste accepted as inevitable & Inadequate pre-planning are the least barriers for the adoption of lean construction principles in Nigerian construction. The result shows that the average severity index of Barriers to the Adoption of Lean Construction 0.724. This indicates that generally the barriers are severe.

Table 4. Severity index of Barriers to the Adoption of Lean Construction

Barriers	Severity		
	Index	%	Rank
Corruption (Unethical Professional behavior)	0.846	84.63	1
Lack of long-term commitment to change and innovation	0.783	78.29	2
Lack of interest from clients	0.781	78.05	3
Lack of adequate lean awareness and understanding	0.776	77.56	4
Lack of holistic implementation	0.761	76.09	5
Inadequate exposure to requirements for lean adoption	0.751	75.12	6
Incomplete design	0.751	75.12	7
Lack of technical skills	0.737	73.66	8
Poor communication	0.734	73.41	9

Inconsistency in government policies	0.729	72.93	10
Lack of top management support and commitment	0.727	72.68	11
Delays in decision making	0.724	72.44	12
Poor procurement selection strategies	0.719	71.95	13
Lack of training	0.717	71.71	14
Misconceptions about lean practice	0.712	71.22	15
Difficulty in understanding concepts	0.702	70.24	16
Fear of unfamiliar practices	0.698	69.76	17
Lack of client and supplier involvement	0.698	69.76	18
Lack of long-term relationship with suppliers	0.695	69.51	19
Government bureaucracy	0.693	69.27	20
Seen as too complex and alien	0.685	68.54	21
Unsuitable organizational structure	0.673	67.32	22
The fragmented nature of the construction industry	0.673	67.32	23
Waste accepted as inevitable	0.673	67.31	24
Inadequate pre-planning	0.651	65.12	25
Average	0.724	72.36	

5.0 CONCLUSION AND RECOMMENDATIONS

The study deduced that while the awareness level of LC is high, its adoption and implementation level is low due to unethical professional behaviors/practice (corruption), lack of long-time commitment to change and innovation and lack of adequate lean awareness and understanding among construction professionals and organizations. When attention is directed to eschewing these barriers to adoption of lean construction principles it will enhance the chance of adopting lean construction for minimizing material waste on project. Thus, it is concluded that the Nigerian construction industry can facilitate the adoption of lean principles by enlightening the Clients to have interest in the use of lean construction in their project, through the assistance, commitment and cooperation of the trained professionals and professional bodies. This study concluded that the barriers are severe to adoption of lean construction. In view of the above study's findings, the study made the following recommendation; with a view to mitigate the barriers for adopting lean construction principles in the Nigerian construction industry.

More awareness of lean construction principles and its potential benefits via education and training to professional bodies, tertiary institutions offering building related courses. The construction professionals should eschew unethical professional behaviours (corruption) in the discharge of their duties, construction managers should be committed to changes, understand client needs & expectations, and maintain continuous improvement that will eventually curtail waste and enhance environmentally friendliness.

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TECHNOLOGICAL INNOVATION IN SHEA BUTTER PROCESSING AND WOMEN EMPOWERMENT IN NIGER STATE

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ABSTRACT

This paper explores the relationship between technological innovation in Sheabutter processing and women's empowerment in Niger State. Technological innovation in Sheabutter processing, its significance in enhancing women's empowerment, and its relevance in agricultural contexts are established. The study adopts a literature review approach to examine the extant works in this context. NEPC (2018) report estimated that the continent of Africa produces 1,760,600 tonnes of raw shea nuts a year. However, domestic applications utilise more than half of this value. The importance of technology in raising agricultural production, efficiency, and sustainability has come to light more and more in recent years. This is especially true in places like Niger State, Nigeria, where cutting-edge innovations and customs coexist, and creating enormous prospects for women's empowerment in industries such as Sheabutter production. In addition to raising agricultural production, these technologies have created new opportunities for economic development, particularly in areas where agriculture is a major source of income for women. However, As good as development is, many local populations still struggle to acquire and implement innovative agricultural implements in Sheabutter processing, especially in Niger State's rural areas. With the advent of contemporary processing technologies, there is now a chance to improve the quality and efficiency of Sheabutter production, raising its market value and enhancing the lives of women who work in the sector.

Keywords: technological innovation, Sheabutter processing, women's empowerment

1.0 Introduction

Globally, technological innovation has been a major factor in the transformation of many industries, including agriculture. The size of the global agritech market was estimated by Zion Market Research to be at USD 23.5 billion in 2022. Experts estimate that it will expand significantly between 2023 and 2030, reaching about USD 79.7 billion at a compound annual growth rate (CAGR) of almost 16.5%. The Nigerian Export Promotion Council (2018) estimates that the continent of Africa produces 1,760,600 tonnes of raw shea nuts a year. However, domestic applications utilise more than half of this value (Kent, 2018). According to Togo, Mali and Nigeria are Africa's top producers of shea kernels (NPC, 2018). The year 2019 saw about 31% of the world's shea nut production come from Mali and over 39% from Nigeria (NPC, 2018). Nigeria produces the majority of its Sheabutter for domestic use (Kent, 2018). Additionally, there is an unreported shea nut trade going on between the nation and

Ghana, Togo, and Benin (Kroll, 2023). The importance of technology in raising agricultural production, efficiency, and sustainability has come to light more and more in recent years (Tweneboah, 2018). This is especially true in places like Niger State, Nigeria, where cutting-edge innovations and customs coexist, creating enormous prospects for women's empowerment in industries like Sheabutter production (Enyinnaya, 2022). The development of high-yield crop varieties and precision agriculture techniques have been transformed by agricultural technology breakthroughs on a global scale (Goyal *et al.*, 2023). In addition to raising agricultural production, these technologies have created new opportunities for economic development, particularly in areas where agriculture is a major source of income (Naangmeyelet *et al.*, 2023). But even with these international developments, many local populations still struggle to acquire and implement contemporary agricultural methods, especially in Niger State's rural areas (Akanwaet *et al.*, 2023). The adoption of innovative techniques is sometimes impeded by limited infrastructure, poor resources, and a lack of technical know-how, which can limit the potential for socio-economic growth (Ayelazuno and Yaro, 2024). This makes the relationship between women's empowerment and technological innovation in shea butter processing an interesting case study (Rousseauoet *et al.*, 2019). The manufacturing of shea butter is a long-standing custom that is intricately linked to the socio-cultural fabric of Niger State communities (Nominshan and Sani, 2023). Women have always had a major role in the entire production process, from gathering shea nuts to turning them into butter (Tanzileet *et al.*, 2023). With the advent of contemporary processing technologies, there is now a chance to improve the quality and efficiency of shea butter production, raising its market value and enhancing the lives of women who work in the sector (Naughton *et al.*, 2017). Women can employ these advancements to boost their income and acquire more autonomy and decision-making authority in their homes and communities (Ayelazuno and Yaro, 2024). This study is to investigate the effects of technical innovation on the processing of Sheabutter and the empowerment of women in Niger State, Nigeria, taking into account both the local potential and difficulties (Zakaria *et al.*, 2021). Understanding the dynamics of technology adoption in the agriculture sector will help us devise ways to assist female entrepreneurs and increase their involvement in the value chain, which will eventually promote inclusive growth and sustainable development in the area (German *et al.*, 2020). Traditional Sheabutter processing techniques in Niger State, Nigeria, provide serious problems, such as inefficiency, limited production capacity, and unpredictable product

quality, which restricts the economic prospects available to women working in this field (Wardell *et al.*, 2021). In addition, there are obstacles that prevent women from fully participating and being empowered in the Sheabutter value chain (Ayelazuno and Yaro, 2024). These include restricted access to contemporary processing technologies, poor training, and a lack of market connections (Abdallah, 2020). By incorporating suitable technological improvements to tackle these issues, it is possible to improve not only the productivity and efficiency of Sheabutter processing but also the economic empowerment of women, which in turn can support sustainable development in the area (Abdullahi and Baba, 2020). The majority of recent research on women's empowerment in Nigeria's agricultural sector has concentrated on the country's southwest and Ghana. Other topics covered include the effects of Sheabutter processing and marketing on rural women's incomes in Ghana's northern region (Sualihu, 2019), the use of improved Sheabutter processing technologies by rural women (Egbunonu *et al.*, 2018), and the empowerment of women through semi-mechanized Sheabutter processing in rural areas (Tanzile *et al.*, 2023). As far as the researcher is aware, there are very few studies that have looked into technological innovation in Sheabutter manufacturing as a whole in North Central Nigeria. The study looks at the connection between women's empowerment in Niger State and technological innovation in shea processing in an effort to close these gaps.

2.0 Sheabutter Processing

The process of extracting, purifying, and preparing Sheabutter for different applications is referred to as "Sheabutter processing" (Oyedele *et al.*, 2020). The fat called shea butter is taken from the nuts of the West African native shea tree (Abubakar *et al.*, 2022). The processes used to separate the natural fat from shea nuts and transform it into a useful product are collectively referred to as Sheabutter processing (Ayelazuno and Yaro, 2024). Cracking, grinding, pressing, and filtering nuts are some of the stages involved in obtaining pure Sheabutter with desired qualities (Umar *et al.*, 2021). Making Sheabutter from shea nut kernels can be done in an industrial or artisanal setting (Ayelazuno and Yaro, 2024). With the goal of creating premium Sheabutter for a range of uses, it combines conventional methods like manual pressing and grinding with more contemporary ones like mechanical extraction and refinement (Okwuba and Williams, 2022).

Shea butter processing model; The Sheabutter business as a whole put together the creation of the Sheabutter processing model, rather than blaming it on any one person or group (Onobhayedo and Airoboman, 2022). Years of traditional knowledge, study, and real-world experience gathered by communities, farmers, processors, researchers, and industry players involved in the shea butter production process have gone into creating the model (Yahya 2020).

A number of groups, academic institutions, and development agencies have helped advance best practices, enhance Sheabutter processing methods, and encourage the long-term growth of the shea sector (Ayelazuno and Yaro, 2024). These include of public and private sector organizations as well as governmental and non-governmental organizations (NGOs), international development organizations, and academic institutions (Dzekoto, 2020).

In general, the model for processing Sheabutter combines conventional techniques, cutting-edge technologies, and creative thinking to optimize the worth of shea nuts while guaranteeing their sustainability, quality, and socio-economic advantages for the communities engaged in the Sheabutter industry (Kgopa, 2022).

Household needs; The term "household Sheabutter processing" describes the procedures and methods used to make Sheabutter for individual or small-scale use in a home environment (Mumin *et al.*, 2023). This frequently entails using conventional or streamlined methods that are doable with readily available household materials and simple equipment (Agundez et al., 2020). People can obtain a natural and unrefined product for personal use on skincare, hair care, cooking, and other uses by processing Sheabutter at home for domestic requirements (Ayelazuno and Yaro, 2024). In addition to participating in a time-honoured craft that has been carried out for generations in areas where shea trees grow, it is a method to take advantage of the health benefits of Sheabutter in its purest form (Ayelazuno and Yaro, 2024).

Technological innovation in Sheabutter processing

Equipment available; the following lists are definitions of common equipment used in the manufacturing of Sheabutter;

i) *A hand tool called a manual nut cracker, ii) traditional mortar and pestle, iii) grinder, iv) hydraulic press, v) cloth filter, vi) storage containers, vii) kitchen scale, and viii) Equipment used to roast shea kernels before grinding.*

A hand tool called a manual nut cracker: is used to crack open shea nuts so that the Sheabutter-containing kernels can be accessed (Umani et al., 2020). Usually, it has two wooden or metal handles with a serrated edge for holding and cracking nuts (Norton, 2021).

A traditional mortar and pestle: is used to pound roasted shea kernels into a paste (Choungo, 2021). The pestle is a heavy, blunt instrument used for grinding and pounding, whereas the mortar is a bowl-shaped container (Dolezalova, 2023).

Grinder: A hand held or electric tool for pulverizing roasted shea nuts into a fine paste (Dhiman and Prabhakar, 2021). While electric grinders usually have revolving blades or burrs to break up the kernels, manual grinders might seem like enormous mortar and pestle sets (Adedeji et al., 2020).

Hydraulic Press: Shea butter is extracted from the shea paste using a mechanical press driven by hydraulic pressure (Goumbri et al., 2021). It has a cylinder, a piston, and a hydraulic system that squeezes the butter out of the shea paste by applying pressure (Garba et al., 2020).

Cloth Filter: To eliminate any last bits of solids or contaminants, the extracted Sheabutter is filtered through a fine cloth or muslin bag (Owodunni and Ismail, 2021). The butter that has been filtered is gathered in a container that sits underneath the cloth filter (Omede, 2021).

Storage Containers: The processed Sheabutter is kept in clean storage containers like metal tins, plastic tubs, or glass jars (Omede, 2021). In order to maintain the butter's quality, these containers need to be sealed tightly and stored in a dry, cool environment (Kaur et al., 2022).

Kitchen Scale: An instrument to gauge how much butter, kernels, or shea nuts are there when processing (Ayelazuno and Yaro, 2024). It contributes to precise measurements and reliable outcomes (Goumbri et al., 2021).

Equipment used to roast shea kernels before grinding: an oven or stove. This can include open flames for traditional roasting techniques, stovetops, and conventional ovens (Joardder and Islam, 2023).

Challenges Faced by women in Sheabutter processing

The difficulties encountered when producing Sheabutter can differ according on the situation, however, the following are some typical ones: Shea nuts are usually only harvested once a

year during a certain season, which causes variations in price and availability all year long (Mumin *et al.*, 2023). Meeting demand and sustaining a steady manufacturing schedule may be difficult due to this periodicity (Kelley *et al.*, 2020). Conventional Sheabutter production techniques frequently entail labor-intensive, physically taxing, and time-consuming operations including cracking, grinding, and pressing nuts (Promjeenet *et al.*, 2024). This reliance on human labor may reduce the efficiency and capacity of manufacturing (Buer *et al.*, 2021). Ecosystems supporting shea trees are threatened by unsustainable harvesting methods, deforestation, and land degradation (Pienaaht *et al.*, 2024). It is quite difficult to strike a balance between the financial advantages of Sheabutter manufacturing and environmental preservation initiatives (Yayah, 2020).

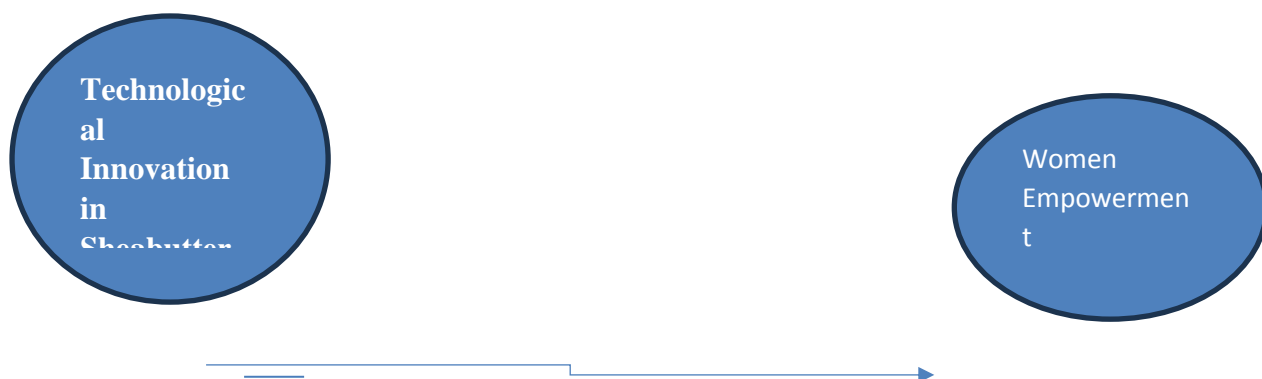
3.0 Women Empowerment

The process of giving women the authority to direct their own lives, establish their own objectives, and make decisions that are essential to their growth on both a personal and professional level is known as women empowerment (Munte and Monica, 2023). It entails guaranteeing that women have equal access to resources and rights in addition to boosting their abilities, self-esteem, and chances (Sen *et al.*, 2023). In order to truly empower women, it is frequently necessary to question the structures and norms of society that support gender inequality, to speak out in favor of gender parity in a range of fields, including politics, business, education, and healthcare, and to create a welcoming environment in which women can flourish and make meaningful contributions to society (Zaremba *et al.*, 2021). In order to guarantee that women have equal rights, opportunities, and resources to fully engage in all facets of society, women's empowerment is understood as a process of questioning and changing prevailing power structures and societal norms (Baqutayan, 2020). From an economic perspective, women's empowerment entails encouraging entrepreneurship and financial independence in addition to expanding women's access to financial resources including finance, land, and job possibilities (Andriamahery and Qamruzzaman, 2022). From a cultural perspective, women's empowerment entails opposing and modifying cultural norms, attitudes, and practices that support gender inequity and restrict the possibilities and choices available to women (Samier and ElKaleh, 2021). As stated in numerous international frameworks, including the Beijing Declaration and Platform for Action and the Sustainable Development Goals (SDGs), women's empowerment is also seen as a global development

goal with the aim of achieving gender equality and women's rights globally (Odera and Mulusa, 2020).

4.0 Sheabutter Processing and Women Empowerment

This study conceptualizes women's empowerment as a single construct, following the lead of earlier researchers in this regard. Through a complex interaction, the features of Sheabutter processing aid in the empowerment of women.



Author review (2024)

5.0 Literature Review

This section offers a review of the empirical research that has been done thus far on the effects of processing Sheabutter and women empowerment. The final goal is to evaluate these papers critically and pinpoint research gaps that this project will attempt to fill.

The characteristics of Sheabutter processing in Niger State, Nigeria, were investigated by Ayanfuke and Kabiru (2020). Sheabutter was conceptualized in terms of four dimensions: i) accessibility at the processor level, ii) outcome at the processor level, iii) elements related to the output of Sheabutter processing, and iv) constraints on Sheabutter processing. In a few chosen local government districts (LGAs) of Niger state, 315 registered shea butter processors provided the necessary information. Chi-square was used to examine the gathered data. The results showed that women's empowerment and shea butter processors are not positively correlated.

Alhassan (2020) investigated how the production of Sheabutter affected basic household necessities in a few districts in Ghana north. Three aspects of Sheabutter processing were considered: processing, obstacles encountered, and policy advice. 110 women from nine chosen districts provided data. Simple regression was used to assess the data that had been gathered. The results demonstrate a connection between women's empowerment and the processing of Sheabutter.

Debnath *et al.* (2020) Investigated Achieving sustainable development through entrepreneurship and economic empowerment of women in the technological era, in Bangladesh. Technological innovation was conceptualized into 3 dimensions i.e. i) Factors that motivate women, ii) Women entrepreneurship support, and iii) Women's economic empowerment.

Gupfa and Sinha (2022) Investigated Wearable technology and women empowerment in the technology industry of India. Technological innovation was conceptualized into 4 dimensions i.e. i) The need to restore balance in society, ii) To empower talented women all over the world, iii) Bridging the gap in the gendered-balance industry, and iv) To make a change and see change. Data was collected through interviews with 100 women from the wearable and related technologies community. The data collected was to analyze the content from the interviews using a thematic analysis-inductive approach. The study revealed that the future of wearable technology seems brighter in the following sectors, AR/VR and artificial intelligence (AI) industries, medical, sport, and fitness sectors.

Sell (2018) Explored innovation capacity and women empowerment in Uganda. Technological innovation was conceptualized into 3 dimensions i.e. i) To support small-scale farmers in transitioning, ii) Identify key constraints and inhibiting factors, and iii) Food security, sustainability, productivity, livelihood, and well-being of small-scale farmers. Data was collected through a survey of 1,440 households of small-scale farmers. The data collected was analyzed using econometric modelling to identify patterns and constraints of women farmers. The study revealed that participating in the innovation system through IP tools, allows especially women farmers to be actively involved. There is a statistical difference in efficiency between the different groups- Women managing plots less efficiently than their men counterparts.

6.0 Conclusion

Considering the critical need to enhance women empowerment in the agricultural sector in Niger State, this paper considers the nexus between technological innovations in Sheabutter processing and women's empowerment in Niger State, Nigeria. The review of the past literature identified two important gaps: i) the methodological gap, and ii) the geographic gap. This study seeks to address using a quantitative approach to get insight on the effect of technological innovation on Sheabutter processing and women's empowerment in Niger State.

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THE EFFECT OF CALIFORNIA BEARING RATIO (CBR) ON BLACK COTTON SOIL BLENDED WITH QUARRY DUST USING THE BRITISH STANDARD LIGHT (BSL) COMPACTIVE EFFORTS

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Abstract

The present study aimed to examine the impact of California bearing ratio (CBR) on black cotton soil when combined with quarry dust, employing the compactive efforts outlined in the British Standard Light (BSL). The initial analysis of the black cotton soil obtained from Baure in Yamaltu-Deba, Gombe State, reveals that the soil falls under the A-6 category in the AASHTO classification system and CL category in the USCS classification system. These classifications suggest that the soil is unsuitable for engineering applications due to its poor quality. The soil was treated using a blend of quarry dust in varying concentrations of 2%, 4%, 6%, 8%, and 10% by dry weight of soil. The compaction process was conducted utilizing the BSL energy. The liquid limit and plasticity index values of the natural black cotton soil are 45.30% and 18.80% respectively. The maximum dry density (MDD) increases from 1.45mg/m³ for the natural soil to a peak value of 1.60mg/m³ when treated with 10% QD, while the optimum moisture content (OMC) decreases from a value of 24.10% to 18.00% for natural and 10% respectively. The unsoaked CBR values increased from 7.82% to 8.84%. It was therefore concluded that quarry dust performs satisfactorily as a cheap modifying agent for sub-base purposes in road construction works.

Keywords: Black cotton soil, California bearing ratio, Compactive efforts, Quarry dust.

1. INTRODUCTION

Soil is often called our first engineering material because primitive man builds his shelters in, of and on this readily available natural material. Difficult is predicting the behaviors of soils in engineering works just the way we can confidently predicts those of steel, concrete or any other building materials. Basically, a geotechnical engineer have to deal with the soil as it exists because mostly it's practically uneconomical to make major modifications to its physical properties.

Among a group of problematic soils is a black cotton soil that is mostly grayish or blackish, fertile, and inorganic clays of medium to high compressibility. Under moisture variation, they are susceptible to shrinking and swelling and are likely to cause damage to any structure constructed over them without any proper treatment. Clay in black cotton soil has a mineral called montmorillonite which makes the soil to be very expansive and when basic igneous rocks breakdown due to seasonal variations in weather, they are produced. It existence is the main reason for the effective water content of the soil and the shrinkage and expansive behavior of the soil (Umar Y. M et.al, 2021).

The soils are formed under conditions of poor drainage from basic rocks or limestone under alternating wet or dry climatic conditions (Osinubi et.al, 2011). Black cotton soil has openings that are around 50mm wide and several mm deep in the dry seasons, the cracks

normally close when it's wet and thereby producing uneven soil through irregular swelling and heaving.

The predominant soil types in Nigeria are a significant concern, encompassing around 104,000km² in the northeastern region. These soils originate from the erosion and decomposition of shaly and clayey sediments, as well as basaltic rocks (Ola, 1983).

Quarry dust is a byproduct generated during the process of blasting and crushing stones in a quarry. It is classified as a waste material resulting from the crushing of stones. Multiple research investigations have demonstrated that the utilization of quarry dust is a cost-effective method for enhancing the properties of unstable soils during ground improvement processes. The presence of coarse and angular particles facilitates effective interlocking of soil particles, hence enhancing the overall strength of the soil through improved interparticle cohesion.

Quarry dust is classified as a hazardous waste material that has detrimental effects on both the environment and human health. In order to mitigate the adverse impacts of these waste products, it is imperative to ensure their appropriate and secure disposal. In order to enhance economic feasibility of disposal, these materials are combined with other construction substances, such as clayey soil, to optimize their utilization for diverse construction applications, including subgrade, foundation base, and embankments. (Ayushi et.al, 2019).

2. LITERATURE REVIEW

Expansive soil is a term generally applied to any soil or rock material that has a potential for shrinking or swelling under moisture conditions (Nelson and Miller, 1992). A lot of damages due occur to light buildings, pavements, and retaining walls structures that are constructed on/over the expansive soils, that is why modifying the soil to improve it characteristics so it can support these structures is imminent and that can best be achieved using waste that is solid in nature. The formation of Nigerian black cotton soil can be attributed to the process of weathering of shaly and clayey sediments as well as basaltic rocks (Osinubi et al., 2011). The phenomenon of soil expansion can be attributed to the existence of clay minerals. The dimensions of clay particles are typically equal to or smaller than 0.002mm. However, Chen (1988) argued that the determination of clay minerals cannot just rely on grain size, as he stressed the significance of the mineralogical composition as the primary attribute of fine-grained soil. According to Chen (1988) and Nelson (2010), the three predominant families of

clay minerals that hold significant importance in the field of engineering are kaolinite, illite, and montmorillonite. Black cotton soil that is expansive in nature exhibits high swelling potential that can be recognized by both field and laboratory tests (Chen, 1988; Nelson, 1992).

Some of the important field identification methods that indicates the potential for expansivity of soils are the following;

- i. A shiny surface is easily obtained when a partially dry piece of the soil is polished with a smooth object such as the top of a finger nail
- ii. The wet samples of the soil is sticky and it will be relatively difficult to clean the soil from the hand
- iii. Appearance of cracking in nearby structures
- iv. They usually have a color of black and/or gray
- v. Open or closed fissures (a joint or similar discontinuity)
- vi. Slickenside (highly polished or glossy fissure surface)
- vii. Shattering or micro shattering (presence of fissures forming granular fragments of clayey soils)

Laboratory identification involves mineralogical identification that identifies minerals in clay particles, like characteristic crystal dimensions, size and shape of clay particles and charge deficiency and surface activity of clay particles. Indirect methods of identification include the simple soil property test. Such tests can be performed in the simple soil mechanics laboratory since the plasticity, swelling and shrinkage characteristics of the soil are to be determined. The direct method is the most accurate and dependable method of determining the swelling potential and the swelling pressure of expansive clay, by just making use of the conventional one dimensional consolidometer.

Quarry dust is one of the mineral solid wastes that are extracted from various activities of mining, but I cannot provide a response without any text from the user. Please Aggregate waste is derived from the process of crushing rubble in order to obtain aggregates. Numerous studies and research investigations have demonstrated that quarry dust is a highly economical and cost-effective method for enhancing the stability of weak or clayey soils using ground restoration techniques. According to Anand et al. (2020), quarry dust is characterized by its rough and pointed particles, which provide effective interlocking between soil particles. This

interlocking mechanism enhances the strength of the soil by promoting better cohesion among its constituent particles.

A study conducted by Akanbi and Job (2014) investigated the appropriateness of utilizing cement and quarry dust to stabilize black cotton soils for road sub-bases and foundations. The researchers examined the effects of including 0-6% cement and 0-20% quarry dust, based on the weight of the dry soil. The laboratory experiments, such as the California Bearing Ratio (CBR), Unconfined Compressive Strength (UCS), and Compaction tests, revealed that the inclusion of quarry dust in various cement proportions led to improvements in the Atterberg's limit of the soil. Additionally, there was a decrease in the plasticity index (PI), liquid limit (LL), and plastic limit (PL), while the maximum dry density (MDD) increased. Furthermore, it was noted that the incorporation of quarry dust led to an increase in the unconfined compressive strength (UCS) and California Bearing Ratio (CBR) values of the stabilized black cotton soil, as the compactive effort was intensified. The soil stabilized with 6% cement and 20% quarry dust components had a peak unconfined compressive strength (UCS) value of 1880 kN/m². Additionally, the California Bearing Ratio (CBR) value attained was 186%.

In a study conducted by Sabat and Bose (2013), the researchers investigated the impact of different mixtures of fly ash and quarry dust, specifically in a ratio of 1:2, on the engineering parameters of an expansive soil. The optimal ratio of fly ash to quarry dust mixture was determined to be 45%.

In a study conducted by Ayushi et al. in 2019, the researchers investigated the potential of utilizing waste material quarry dust for stabilizing black cotton soil. The study findings revealed that the addition of quarry dust in equal proportions resulted in an increase in the California Bearing Ratio (CBR) value from 11.53% to 15.28%, up to a maximum of 10% quarry dust content. In their 2021 study, Rajashekar M. and Manyamkonda K. examined the application of stone dust as a stabilizing agent for black cotton soil. Their findings indicate that the California Bearing Ratio (CBR) percentage exhibits a growing trend until the stone dust content reaches 15% in the soil. Subsequently, the CBR percentage drops as the stone dust content continues to climb. Therefore, it can be concluded that a stone dust concentration of 15% is the optimal proportion for the material in the soil. The maximum dry density of the material is recorded as 1.94 grams per cubic centimeter, while the optimal moisture content is determined to be 18.91% when the stone dust content is at 15%. It is seen that any additional

increase in the stone dust content leads to a decrease in the maximum dry density and a rise in the optimum moisture content.

3. METHODOLOGY

Laboratory tests were carried out in order to determine the following properties for both the natural and treated soil

- i. Specific gravity
- ii. Atterberg Limit (Plasticity Index)
- iii. Maximum dry density and Optimum moisture content
- iv. California Bearing Ratio

4. RESULTS AND DISCUSSION

The laboratory tests completed were subjected to a brief discussion of their results, with a subsequent evaluation of the impact of quarry dust in each instance. The conducted tests encompassed the study of grain size, determination of Atterberg limits, evaluation of soil compaction through the moisture-density relationship, and assessment of the California bearing ratio. The samples were subjected to a curing period of 7 days prior to the commencement of the testing.

Characteristics of materials employed in the investigation

The initial tests were conducted, and the soil was categorized using the American Association of State Highway and Transportation Officials (AASHTO) system as A-6, and the Unified Soil Classification System (USCS) as (CL), indicating that the soil's performance as a subgrade material is deemed to be of fair to poor quality. The clay group known as Sandy Lean Clay exhibits a relatively low level of plasticity based on the categorization system established by the United States Department of Agriculture's Unified Soil categorization System (USCS). The table below presents a summary of the diverse test outcomes acquired for the categorization of the natural soil sample, alongside the USCS classification and compaction results utilizing the British Standard Light (BSL) energy level.

The following table presents a concise summary of the soil stabilization effects of quarry dust.

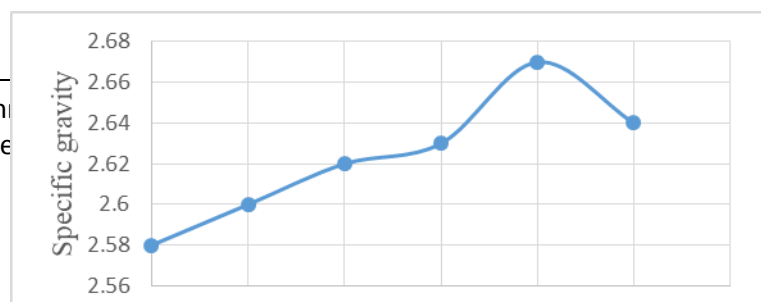
Table 1: Properties of the Natural Soil and Quarry dust fine

Properties of	Natural soil	Quarry fine
Natural moisture content %	22.06	
Liquid limit (%)	45.30	
Plastic limit (%)	26.50	
Plasticity Index (%)	18.80	
Linear Shrinkage (%)	12.10	
Percentage passing BS No 200 sieve (%)	83.35	
AAHSTTO Classification	A-6	
USCS Classification	CL	
Specific gravity	2.58	2.65
Maximum Dry Density (Mg/m ³)	1.45	
Optimum Moisture Content (%)	24.10	
Colour	Black	Grey
California Bearing Ratio (CBR) (KN/m ²)	202.57	

Effect of Specific gravity test

The specific gravity of the quarry dust was obtained as 2.65 and that of the natural soil as 2.58, and the result was found to increase from 2.58 to a value of 2.60 at a 2% increment of quarry dust, it increased at 4%, 6% and 8% to 2.62, 2.63 and 2.67 respectively, a sudden decrease is obtained at 10% to 2.64. These variations in result were as a result of high density material being replaced with a less dense one as specific gravity is related to the material sample.

The summary of the Table and graphical illustration of the GS result variations are presented in the figure below:



Grain size analysis (Sieve Analysis)

The test was run only on the natural soil sample with a total weight of 200g. The dry sieving result was obtained after the wet sieving were the total percentage of material passing B.S sieve no 200 (75gm) was obtained as 71.65%. It is presented in the table shown below attached to the corresponding graphical illustration.

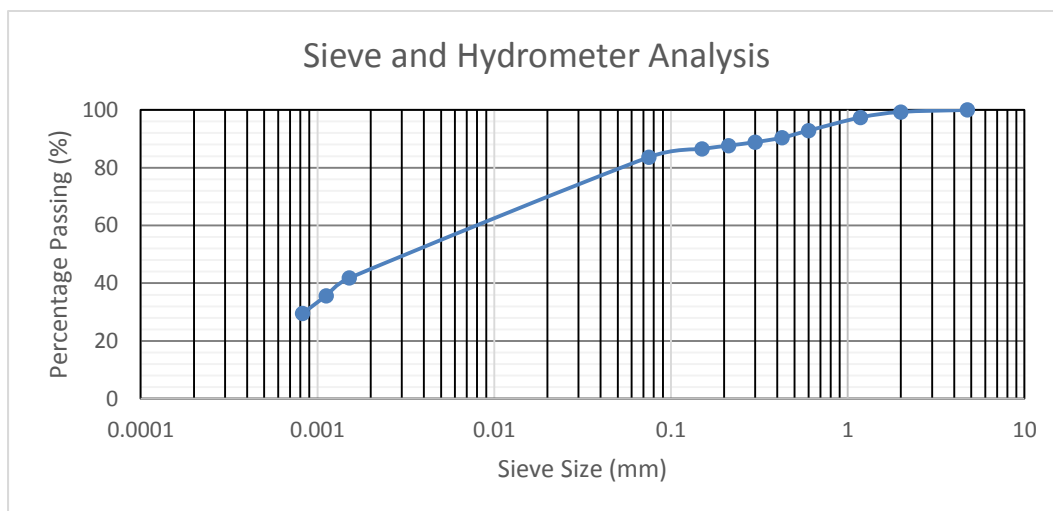


Fig. 2: Particle Size Distribution Test Result

Effect of quarry dust on the Atterberg Limits

Atterberg limits tests performed shows that the liquid limit decreases with an increase in the quarry dust from 0% to 4% but increase to 6% before further reductions at 8% and 10%. The maximum decrease in the Plasticity Index (PI) value is at 10% quarry dust which is from 19.73% to 16.83%. The summary of the results for the varying percentages of quarry dust is tabulated.

Content of quarry dust (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
0	45.3	26.5	18.80
2	44.08	26.25	17.83
4	43.0	25.5	17.50
6	45.14	25.41	19.73
8	40.45	23.42	17.03
10	39.48	22.65	16.83

Table 2: Effect of quarry dust on Atterberg Limit

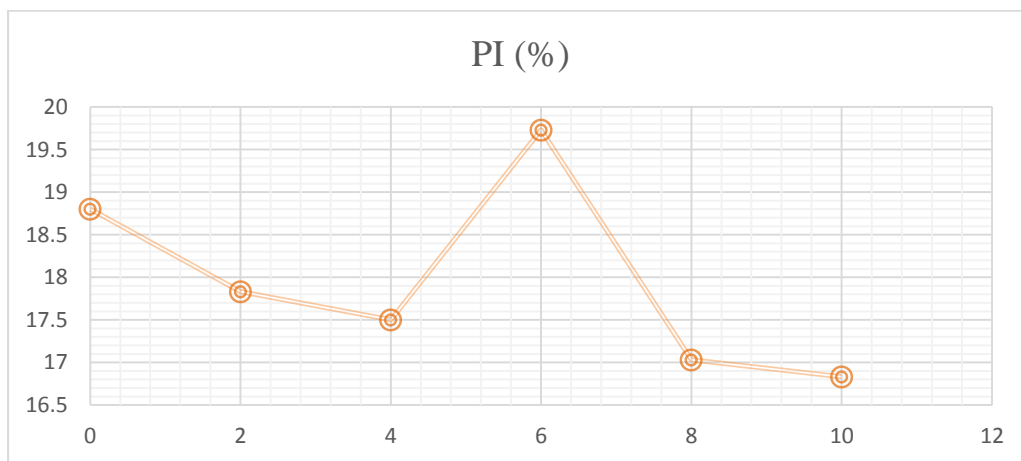


Fig. 3: Effect of quarry dust on Plasticity Index of the soil

In general, the decrease in the PI is as a result of the partial replacement of the expansive soil with quarry dust which is non-plastic material.

Effect of quarry dust on the moisture-density relationship

A British standard light energy level was carried out and moisture content versus dry density graphs for each percentage of quarry dust was produced leading to the determination of optimal moisture content and maximum dry density. The summary of the tests results for varying percentages is tabulated.

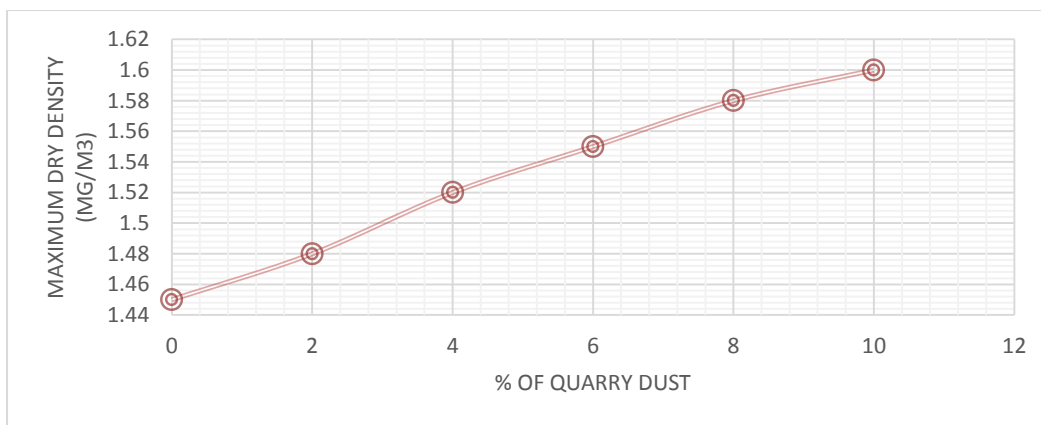


Fig. 4: Effect of quarry dust on maximum dry density

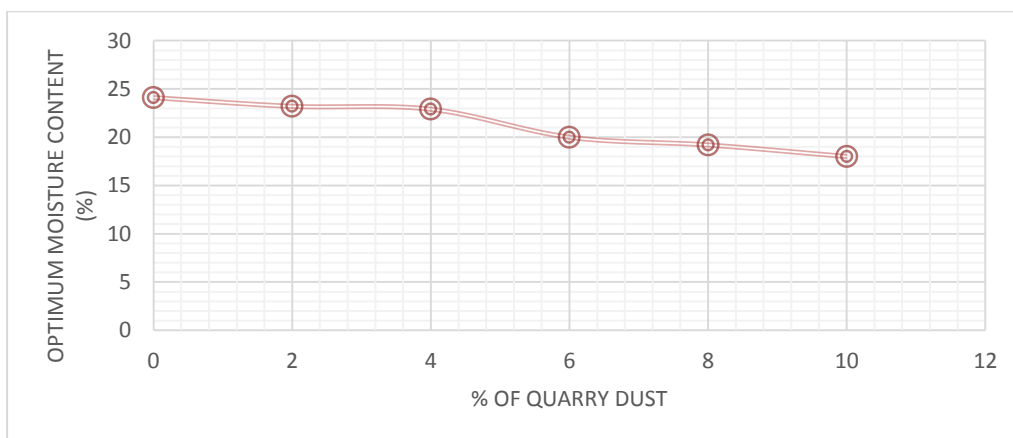


Fig. 5: Effect of quarry dust on optimal moisture content

From the graphs, it can be seen that with an increase in the percentage of the quarry dust, the optimal moisture content decreases while the maximum dry density increase. This may be

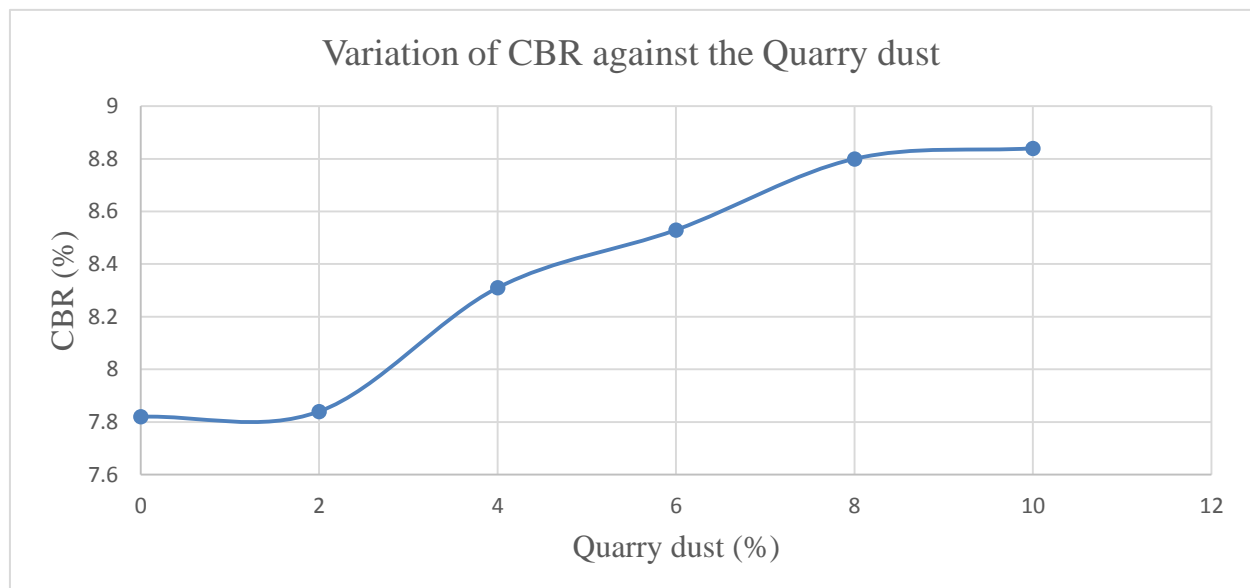
due to the addition of quarry dust, which cause less absorption of water and the chemical reactions taking place in the soil-quarry dust mixtures respectively.

Effect of Quarry Dust on California Bearing Ratio (CBR)

The CBR was performed at the MDD and OMC of the expansive soil with the addition of quarry dust from 2% to 10%. It is observed from the results that the CBR values increases with an increase in the percentage of the quarry dust. Treating the expansive soil at 10% produces a peak value of 8.84% compared to the value of natural soil that is 7.82%.

Table 3: Effect quarry dust on CBR (%)

Content of quarry dust (%)	CBR Value (%)
0	7.82
2	7.84
4	8.31
6	8.53
8	8.80
10	8.84



5. CONCLUSION

This study aimed to evaluate the impact of quarry dust on the California bearing ratio (CBR) of black cotton soil obtained from Baure in the Yemaltu-Deba Local Government Area of Gombe State. The assessment was conducted using the guidelines outlined in the British Standard methods BS 1377 and BS 19211 (1990), which involved the utilisation of BSL compactive energy. The expanding soil underwent treatment with quarry dust in varying proportions of 2%, 4%, 6%, 8%, and 10% based on the weight of the soil. Based on the analysis and observations conducted in the research, it is possible to derive the following

findings. The soil falls into the A-6 clayed soil subgroup as per the AASHTO classification system. The soil's plasticity can be inferred from its liquid limit and plastic limit, which have been measured at 45.30% and 26.50% respectively. These results indicate that the soil falls below the standard required for a majority of geotechnical applications.

Quarry dust is employed as a stabilizing agent to enhance the geotechnical attributes of expansive soils, resulting in notable enhancements in the index properties, compaction, and strength characteristics of the expansive soil being investigated. The impact of quarry dust is contingent upon the quantity of quarry dust that is incorporated into the soil samples. The shrinkage limit tends to decrease as the concentration of quarry dust increases, hence regulating the soil's volume change characteristics in response to fluctuations in moisture content throughout seasonal variations.

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PROPERTIES OF CONCRETE INTERLOCKING PAVING BLOCKS INCORPORATING COCONUTFIBRE

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ABSTRACT

Excessive overdependence on asphalt for paving roads in Nigeria create a vacuum that needs to be filled with a better, environmentally friendly and sustainable paving material. Interlocking paving blocks reinforced with Coconutwaste fibre turns out to be a viable alternative to fill this gap. The increasing consumption of Coconut due to the changing lifestyle and more awareness of its importance lead to the production of appreciable waste fibre. Burning of the fibre and Coconutshell constitute environmental concern, thus, it's inclusion in paving bricks for construction purpose will ameliorate the menace. This research investigates the performance of Coconutfibre reinforced interlocking paving blocks (IPB) made from the addition of shredded Coconutfibre 5, 10 and 15 percentage by weight of the block. Rectangular (bevelled/brique shaped) 300 mm x 100 mm x 80 mm (length x width x thickness) interlocking blocks casted with a 0.60 water cement ratio (w/c)

by a manual vibration were produced. Both control and fibre-modified blocks were tested for compressive strength, split tensile strength, and flexural strength. Results showed that the compressive strength of all fibre-modified blocks surpasses that of the control blocks and experienced a steady increasing in compressive strength with increasing fibre content with a maximum value of 29.2 N/mm² at 28 days curing. The split and flexural strength tests indicated significant improvement at a maximum value of 3.8 and 3.7 MPa respectively.

Keywords: Interlocking Paving Block, Coconutwaste fibre, flexural strength, split tensile strength.

Introduction

Interlocking paving blocks (IPB) are a special mix pre-cast piece of concrete commonly used in exterior landscaping and paving applications. The interlocking paving blocks (IPB) are jointed to form a monolithic non-mortar jointed arrangement forming the wearing course of light-to-medium trafficked roads, streets, driveways, sidewalks, garages, and parking lot [1]. Usually, IPB are unreinforced regular-sized, precast elements made from cement, aggregate, water and some additives laid unjointed on bedding sand in different patterns to form a homogenous continuous bed serving as pavement wearing course [2,3]. IPB has the desirability of ease of ease and speedy laying, flexibility of laying to different patterns, cheaper maintenance, resistance to expansion cracking due to ample spacing between units, total absence of potholes unlike flexible pavements, highly sturdy and artistically pleasing surfaces [2,4]. The construction industry is witnessing a revolutionary era of advanced automation/sophisticated construction tools/techniques and the use of advanced high performing construction materials like polymers, epoxies, industrial/agricultural/municipal waste, and ultimately fibres [5]. The increasing demand for paved roads as a consequence to population growth and spike in automobile demand necessitates alternative to asphalt pavements for light to medium trafficked roads [6]. A consistent growth rate in the use of IPB of 100% for a five year period was recorded in the USA and similar trend was observed in parts of Europe and Africa which could not be unconnected to its desirability for use in heavy-duty low-speed trafficked pavements like wharves, jetties, dockyards, taxiways, and industrial roads [7]. Thus, IPB paved roads' mechanical performance enhancement became a source of concern for researchers and other stakeholders alike. Consequently, the durability, strength, and mechanical performance of IPBs needed to be enhanced more than ever before, this result in the inclusion of various additives, substitutes, and chemicals into IPBs. Some of these materials are employed in high strength concrete and concrete interlocking paving blocks.

Among these high-performance materials, Coconutfibre (Coir) is a favoured material for its high tensile strength to weight ratio, ability to be moulded into various shapes and potential resistance to environmental conditions, resulting in potentially low maintenance cost. Coconutplants thrives well in tropical wet climatic regions of the Earth in parts of Africa, Asia, and Pacific. The global production of Coconutis in excess of 61.5 million metric tons per annum[8].Coconutfibre is extracted between the hard, internal shell and the outer coat of a Coconutfruit.Coconutfibre is used for making various products like ropes, floor mats, doormats, body armour, brushes, and mattresses. More So, Coconutfibreropeused in fibre reinforced concrete (FRC) is gradually gaining acceptance globally, it was proven that the axial pullout behaviour and tensile capacity ofCoconutfibre rope in earthquake resistant low-cost housing to be effective – though dependent on fibre embedment length and treatment method [9].However, a most recent review on the use of Coconutfibre for civil engineering applications (and concrete) suggested that fibre lengths < 50 mm and fibre content < 1.5% ofvolume were inferred to be the optimal combination yielding improved tensile, compressive, and flexural strengths of the concrete[10]. Conversely, utilising a replacement percentage by weight between 5- 20% by weight of natural and artificial fibre in concrete is feasible as evidently used in asphalt concrete as well [11,12].

A proponent on the use of natural fibres for construction purposes is the high cost involved, non-availability and corrosion challenges associated with steel fibres. Coconutfibre is biodegradable, relatively water-proofand is the only natural fibre resistant to damage by salt waterand being the most ductile among all natural fibres[8,11]. Moreover, sustainability efforts, reduction in the usage of non-renewable resources and mitigating landfill disposal of waste/by products like the ‘green deal’ of the European Union amongst others motivate this research to further extent the application of Coconutfibre[13].

A comprehensive review on the bonding characteristics between fibre and concrete composites suggested more studies on the bond and tensile strength of fibre-concrete composites [14]. Despite having a higher compressive strength than asphalt pavement and a relatively comparable to that of reinforced concrete pavement, yet, its weakness in tensile strength is a source of concern to researchers which need redress[7]. Nonetheless, research effort geared towards improving the tensile strength of IPB for increased versatility.Therefore, this study aimed to identify the improvement in strength characteristics

of concrete IPB in terms of compressive, tensile, and flexural strength with the addition of Coconutfibre.

2. MATERIALS AND TEST METHODS

The materials sourced and the test methods used were ensured to conform to the relevant ASTM standard. The fine aggregate used passes through the sieve size 4.75 mm and retained largely on sieve 2.36 mm and conformed to ASTM C33/C33M [10][15]. The Coconutfibre was sourced from the southern part of Nigeria and was washed in distilled hot water after soaking for 3 hours. The Coconutfibre was dried and cut into pieces of between 5 – 10 mm at 5 – 15% replacement by weight of the IPB [16]. Underground sourced potable water collected from the Laboratory was used for mixing IPBs mixes. The physical properties and grading curves for the coarse and fine aggregates used for the study are presented in Fig. 1 and Table 1.

2.1 Materials

2.1.1 Cement

This research work employed a standard setting cement (Ordinary Portland Cement - OPC) conforming to ASTM C150 [17]. Dangote cement brand obtained from retailers was utilised for this study for it yield a total of 42.5N strength per 50 kg bag if mixed with the proper water/cement ratio. For quality assurance cement was stored in air-tight containers in dry ventilated shelves before usage within the laboratory.

2.1.2 Aggregates

The tested properties of the fines and coarse aggregates used for the study is given in Table 1. The sieve analysis for both fine and coarse aggregate conforms to ASTM C33/33M-13[18]. Sieving was conducted after the samples were thoroughly washed and oven dried in the oven for three (3) days at $105 \pm 5^{\circ}\text{C}$. Drying for three (3) days was adopted so as to cater for the intermittent power outages experienced in the test laboratory. The chemical, morphological and structural characteristics of the aggregate were not tested due to lack of machinery and less impact on the study's outcome as earlier identified by researchers, rather, the type of Coconutfibre treatment used[19].

The coarse aggregate has higher specific gravity, lower sand equivalent, and much high value of impact value (AIV) resistance. The higher AIV compares to ACV suggested that the

coarse aggregate will resist more impact load than crushing load, nonetheless, both the two values are within safe limits specified by the British Standard and the Federal Ministry of Works' specification for Roads and Bridges.

Table 1.

The physical and mechanical properties of the aggregate

Physical Properties	Coarse aggregate	Fine aggregate
Colour (appearance)	Light pinkish-grey	Brownish-pink
Specific gravity	2.63	2.14
Soundness (%)	1.4	N.A
Percent passing 2.36 mmsieve (%)	42.17	83.66
Sand Equivalent (%)	6.3	10.2
Fine Aggregate Angularity (FAA) (%)	N.A	57.21
Aggregate Impact Value (AIV) (%)	9.61	N.A
Aggregate Crushing Value (ACV) (%)	10.2	N.A

The grading curve presented in Fig. 1 indicated that a medium coarse gravel was utilised as the case aggregate for the IPB. The reason is that larger or coarser fractions of aggregate in excess of 19 mm yield greater voids difficult in manual vibration of the freshly casted IPBs.

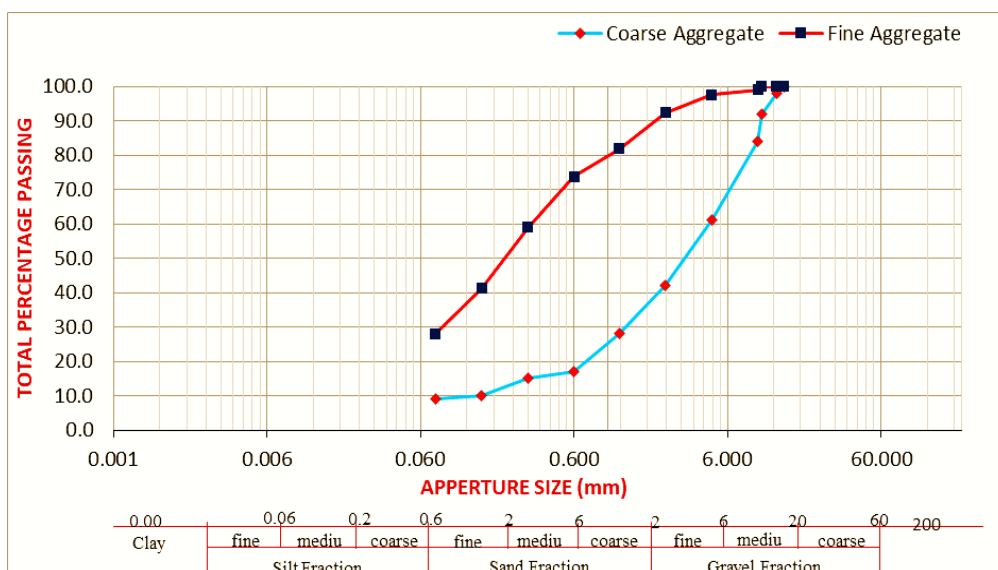


Fig. 1. Grading curves for the coarse and fine Aggregate

2.1.3 Coconutfibre (Coir fibre)

Scientifically, Coconutfibre or Coir which is extracted from the husk of Coconutfruit, is referred to as *Cocos nucifera* and *Arecaceae* (*Palm*), it is abundantly available in tropical regions. There are two (2) common types of Coconutfibres, brown fibre extracted from matured Coconutfruits and white fibres extracted from immature Coconutfruits[8]. Brown fibres are thick, strong with high abrasion resistance. White fibres are smoother and finer, but also weaker. Coconutfibres are commercially available in three forms, namely bristle (long fibres), mattress (relatively short) and decorticated (mixed fibres). These different types of fibres have different uses depending upon the requirement. In engineering, brown Coconutfibres are mostly used. Several engineering applications of Coconutfibre ranging from mortarless building earthquake-resisting bricks, interlock paving blocks, asphalt concrete, and even as alternative reinforcing bars in concrete were envisaged in the literature [4,8,9,16,20–24]. For this study, the brown fibre obtained from the southern part of Nigeria was used.

Table 2.

Some key properties of Coconutfibre from the literature

Parametric Properties	Coconutfibre	Others
Colour (appearance)	Reddish Brown	Varies
Density (g/cm ³)	0.80 – 1.44	0.70 – 7.80
Modulus of Elasticity (GPa)	0.50 – 22.40	-
Tensile strength (MPa)	11.00 – 500	80.00 – 4800.00
Diameter (mm)	0.11 – 0.60	0.10 – 0.80
Elongation at breakage (%)	14.00 – 51.00	1.00 – 13.00
Cost of chopped fibres (USD/kg)	0.17 – 0.21	0.16 – 50.00

Source: [8,10]



(b-1)

(b-2)



(a)

(c-1)

(c-2)



(d)

(e)

(f)

Fig. 2. Coconutfibre types and uses (a) Coconuttree, (b-1) white Coconutfruit, (b-2)white Coconut fibre, (c-1) brown Coconut fruits, (c-2) brown Coconut fibre, and (d – f) Coconut fibre products (d) rope, (e) cooking

briquette and (f) body armour.

As indicated in Fig. 2, both the white and brown Coconut fibres are extracted from in between the hard brownish surface of the fruit shell itself to the outer softer greenish surface layer of the fruit Fig. 2 (b-1) & (c-1). All the two categories of fibres are used in the production of numerous products ranging from household items, marine rope (boat & fishing line) and body armour.

2.1 Test Methods

2.1.1 Mix preparation

The Coconut fibre is soaked and washed in distilled warm water to remove dirt and any unwanted material. The aggregate is quartered using the ripple box and proportioned in the ratio 1:3:3 (Cement: Fine Aggregate: Coarse Aggregate). A prime mix of sand/cement mortar was mixed with the same w/c which is to be placed inside the moulds first before pouring of the concrete mix. The fine and coarse aggregate were mixed dry, then water (w/c 0.60) was added to the mixture and mixed thoroughly until homogeneity is attained. A high-water content was used based on experience of producing such blocks for ease of vibration and smoother surfaces.

Fig. 3 (a) & (b) shows sample casted IPBs and soaked Coconut fibre after removal from water respectively.

The moulds were oiled followed by the primer mix, and then the mixed fresh concrete is poured into the moulds. They were demoulded after 24 hours and immersed into curing tank for the various curing ages of 7, 14, and 28 days. Usually, IPBs are air-cured in all retail outlets, but for research purposes and to ensure adequate hydration of all cement content, curing in water was adopted.



(a)



(b)

Fig. 3. (a) Casted control samples of IPBs, (b) Coconut fibre after soaking

2.1.2 Compressive strength test

After demoulding, the IPBs were wiped off any moisture, weighed and tested in a universal compression testing machine in accordance to ASTM C39/C39M[25]. A gradually increasing monotonic loading was applied on the sample at a rate of 0.07 mm/s. The load was applied on the flat surface of the IPB for uniform pressure distribution. To cater for uneven loading due to the surface roughness and irregularities on the dried IPBs, a thin wooden sheet of uniform diameter was placed on each of the IPBs during testing. Failure loads were recorded on dial gauges equipped unto the machine. The test set up for testing the compressive strength of the IPBs is depicted in Fig. 4



Fig. 4 Compressive strength test set up before loading starts

2.1.3 Splitting Tensile Strength test

This test is utilised to evaluate the shear resistance of lightweight structural concrete elements, IPBs inclusive. The test was conducted in accordance to ASTM C496/C496M-11 with modification to the specimen dimension[26]. Unlike in the compressive strength test, plywood was not used on the surface of the IPBs, rather samples were loaded directly. The Universal testing machine used for the test was equipped with splitting edge that diagonally cut through the loaded samples during testing.

The failure load on and area of each IPB tested was noted and the resultant splitting tensile strength calculated in units of force per area. Fig. 4 shows a typical test set up for the splitting tensile strength test.

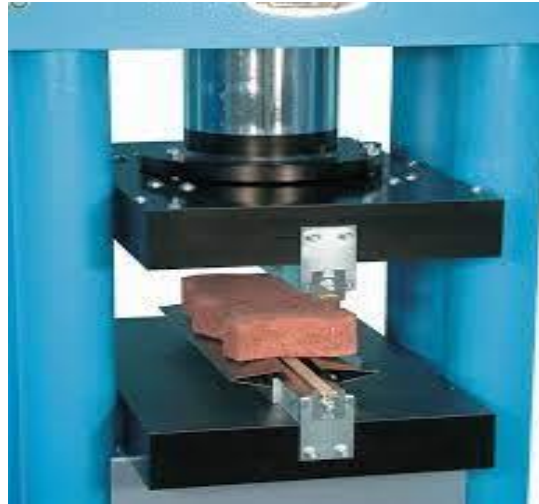


Fig. 5. Test set up for splitting tensile strength test

2.1.4 Flexural Strength test

Flexural strength or modulus of rupture was obtained by loading unreinforced concrete specimens of length thrice their thickness. For this study, the test was conducted following ASTM Standard C78/C78M[27]. The specimen was prepared following the guidelines on ASTM C 42. The testing set up is similar to the three-point beam bending test and measures the resistance of a beam (in this case, IPB) to bending failure. For this purpose, the samples were not allowed to dry before testing as this may hamper the result. Flat smooth wooden flanks were used as bearing blocks to ensure that the applied forces on the samples were applied perpendicularly to the surface of the IPB without eccentricity. Fig. 5 shows a schematic for the flexural test set up which emphasizes the depth to length ratio.

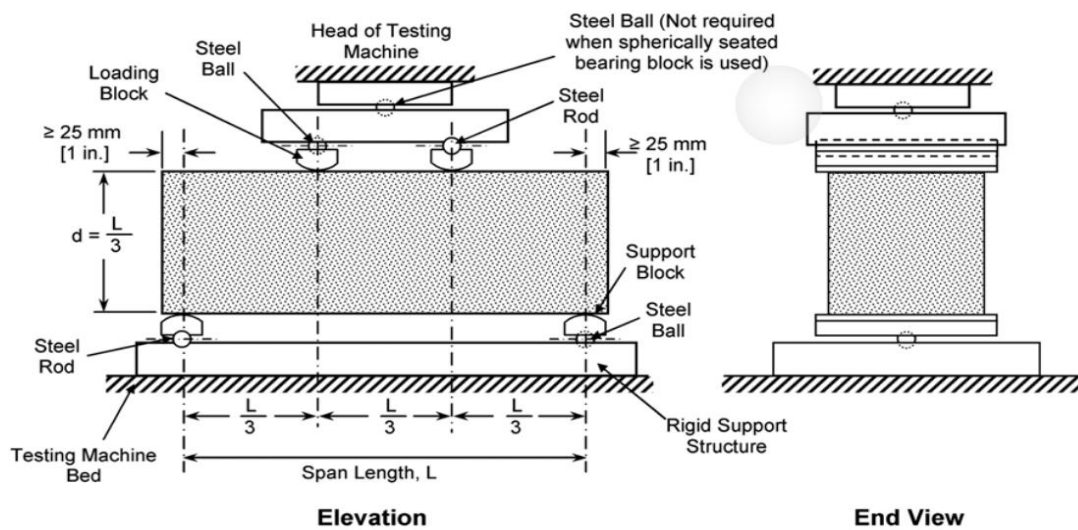


Fig. 5: Schematic of a Suitable Apparatus for Flexure Test of Concrete by Third-Point Loading Method

Source: ASTM C78 [27]

3. RESULTS AND DISCUSSION

3.1 Compressive strength test result

Result of the compressive strength test on the control and Coconut fibre reinforced IPBs is presented in Table 3. The result suggested a progressive increase in strength from the 5 – 10% fibre addition with a slight decline at 15% fibre content. with the exception of the 15% fibre content, all the other IPB categories including that of the control samples experienced strength gain with longer curing age. The percentage strength gain of the average compressive strength with increasing duration of curing from 7 – 14 days is 97%, and 68% from 14 – 28 days, suggesting a gradual decline in compressive strength.

The overall maximum compressive strength of 29.2 N/mm^2 was achieved with the 10% fibre content after which a decline at 15% was recorded.

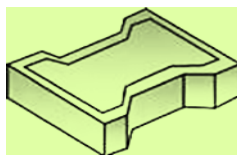
3.2 Splitting Tensile Strength test result

The tensile split strength test result is presented in Table 4. The trend is somewhat the same as that for the compressive strength whereby there is an improvement in strength with longer curing age and with increasing fibre addition between 5% to 10%. Whilst a decline is

recorded at 15% fibre, which could be as a result of the reduced bond strength with higher surface area of fibre as earlier highlighted from the literature [28].

Table 3.

Result of Compressive strength test on IPBs for the three (3) curing age



		Specimen	Compressive Strength (N/mm ²)			Maximum
			7	14	28	Compressive
			days	days	days	strength
						(N/mm ²)
	5	1	11.6	13.5	16.7	
		2	11.9	11.8	20.0	20.0
		3	13.5	12.7	19.8	
		Average	12.3	12.7	18.8	
	10	1	12.4	19.1	29.2	
Percentage fibre content (%)	10	2	15.3	18.4	24.8	29.2
		3	14.6	21.3	25.6	
		Average	14.1	19.6	26.5	

		1	15.6	13.8	20.8	
	15	2	16.9	17.7	23.4	24.3
		3	17.8	16.7	19.5	
		Average	16.8	16.1	21.2	
Control		1	8.55	12.67	13.51	
samples	0	2	9.96	11.98	12.58	14.63
(%)		3	10.8	11.27	14.63	
		Average	9.77	11.97	13.57	

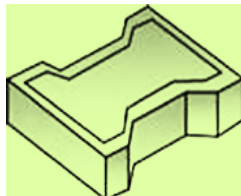
3.3 Flexural Strength test result

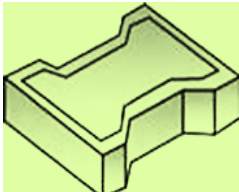
The average flexural tensile strength result for samples with varying percentage of fibre is given in Table 5. The flexural strength progressively increases with increasing curing age up to 28 days and with increasing fibre content up to 10% fibre addition. At 15% Coconut fibre content, the value of the flexural strength declined, thereby aligning with the trend of the compressive and tensile split strength results.

The flexural strength in Table 5 was not as high as it was expected arguably due to the total water immersion curing and partly due to fibre content, though a research opined that higher w/c (0.7%) is key in achieving such strength [7]. Furthermore, the maximum recorded flexural strength was with the 10% fibre content after which the value declined at 15% suggesting an optimal percentage for Coconut fibre reinforced IPBs is 10%. This point is concomitant to the results for compressive and tensile split strengths alike.

Table 4.

Result of Tensile Split Strengthtest on IPBs for the three (3) curing age



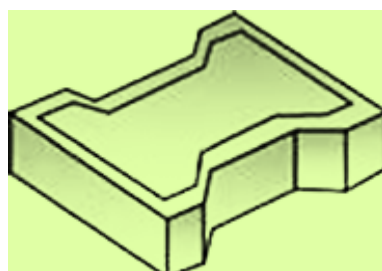
		Specimens	Tensile	Split	Strength	Maximum
			(MPa)			recorded
			7	14	28	split
			days	days	days	strength(MPa)
	5	1	1.9	2.7	3.3	
		2	2.4	2.5	3.4	3.7
		3	2.1	3.1	3.7	
		Average	2.1	2.8	3.5	
Percentage fibre content (%)	10	1	2.6	3.2	3.5	
		2	2.9	2.8	3.4	3.8
		3	2.1	3.7	3.8	
		Average	2.5	3.2	3.6	
	15	1	2.7	3.0	2.6	
		2	3.1	3.4	2.8	3.4

		3	2.8	2.9	3.3	
		Average	2.9	3.1	2.9	
Control		1	1.9	1.8	2.5	
samples	0	2	1.7	2.2	2.8	3.1
(%)		3	1.6	1.7	3.1	
		Average	1.7	1.9	2.8	

Moreover, the flexural strength of the control samples with zero (0%) fibre addition indicated that it has appreciable strength that can withstand monotonic traffic loading. This is so because it is common that IPBs are usually unreinforced in the market. Interestingly, there is a slight reduction of flexural strength at 15% fibre addition across all curing ages. The percentage reduction could be attributed to reduced bond strength between cement paste and the fibre.

Table 5.

Result of the average flexural Strength test on IPBs for the three (3) curing age



Percentage fibre content (%)	Tensile Strength (MPa)			Split Maximum recorded split strength(MPa)
	7 days	14 days	28 days	
0	1.9	2.7	3.3	
5	2.4	2.9	3.4	

	10	2.1	3.4	3.7	3.7
	15	2.0	3.2	3.5	
Maximum flexural strength per curing age		2.4	3.4	3.7	

4. CONCLUSION

Result of the physical and mechanical strength of the constituent materials have conformed to relevant Nigerian and British standards for roads applications. Moreover, the results from the study showed that the compressive, tensile split and flexural strengths of the Coconut fibre modified is beyond nominal values encountered with in the literature and comparable to IPBs made from addition of other synthetic and natural fibres. With a maximum value of compressive, tensile split and flexural strengths of 29.2N/mm², 3.8MPa, and 3.7 MParespectively, Coconut fibre reinforced IPBs can comfortably be used for paving applications in light to medium trafficked roads with heavy axle loading. Thus, Coconut fibre was found to improve the mechanical characteristics of concrete IPBs.

5. SUGGESTION FOR FURTHER STUDY

It is recommended that a deeper investigation on the chemical, morphological, microstructural and bonding characteristics be conducted on IPBs to establish the relationship between the strength development or otherwise in terms of these parameters. Furthermore, the study could be extended to cover the various types of Coconut fibres and be applied at a specified strand length

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MARKET ORIENTATION AND PERFORMANCE OF POULTRY BUSINESS IN MINNA METROPOLIS. A CONCEPTUAL REVIEW.

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Abstract

Poultry production is one of the important components of the livestock subsector in the Nigerian economy, which can be embarked upon by the people with small or no land capital. Despite these assertion, Challenges persist in the poultry production sector in Minna metropolis. Hence, the paper adopts a conceptual review from reputable data base that examined different dimensions of market orientation in relations to performance of poultry business with a view to have synthesis of commentaries on the concept and theory from existing literature. The major gap of the review were identified in order to justify the need for further studies. The study was premised on market orientation theory. A conceptual framework that outline the relationship between variables in the review created. The findings of this study provide recent update on dimension of market orientation as it positively influences the performance of poultry business in Minna metropolis. It is recommended that poultry businesses should invest in robust data collection and analysis systems to better understand market trends, customer preferences, and competitor strategies.

Keywords: Market Orientation, Performance, Poultry Business, Market Orientation Theory.

Introduction

In today's competitive business landscape, the rivalry among firms has reached unprecedented levels, making the acquisition and maintenance of a competitive edge essential for survival (Peterson and Crittenden, 2020). Every firm's primary objective is to attain sustainable competitive advantage (SCA) and maintain a leading position in the market (Zhao, 2022). The increasing competition globally underscores the importance of integrating

effective market orientation for the survival and growth of entrepreneurial businesses (Baber *et al.*, 2020).

Poultry production is one of the important components of the livestock subsector in the Nigerian economy, which can be embarked upon by the people with small or no land capital (Omisakin, 2019). Nigeria's poultry industry is composed of local unimproved breeds and the high performing commercial breeds (Thoumrungroje and Racela, 2022). Over the last 50 years, the exotic breed has made an aggressive incursion into the production economy of the country, while the local chicken is driven by traditional system management, the exotic breeds have stimulated an industrial advancement of the poultry industry through specialization as egg or meat type strains to satisfy the increasing demand for poultry commodity in the food market (Dada *et al.*, 2023). It provides direct employment for a large number of rural and urban people and indirect employment to suppliers of products and services such as grain farmers, feed mill operators as well as those producing various goods and services used to support poultry production and marketing activities (Omisakin, 2019; Dada *et al.*, 2023).

In addition, Poultry is considered to be a means of livelihood and a way of achieving a certain level of economic independence in Nigeria (Omisakin, 2019). The primary purpose for keeping poultry in all parts of the country is for both dietary and economic reasons (Dada *et al.*, 2023). Poultry as an aspect of livestock production is important to the biological needs, economic and social development of the people in any nation (Omisakin, 2019).

More so, for poultry businesses to thrive in this global competitive market environment, firms must operate efficiently to reduce costs, enhance product value, retain existing customers, attract new ones, and ultimately improve profitability in order to achieve desirable organisational goal (Yeo *et al.*, 2019). As competition intensifies with the proliferation of poultry businesses, the rivalry for survival becomes fiercer, driving firms to adopt diverse market orientation strategies to optimize operations and maximize returns on investment (Palazón *et al.*, 2022). Consequently, the competitiveness of firms is reflected in their strategic business approaches, with market leaders commanding the largest market share (Morales and Ruiz-Alba, 2019).

Market orientation is recognized as pivotal to the performance of business firms, providing a strategic framework for understanding and satisfying customer needs effectively (Habel *et al.*, 2020). Firms embracing market orientation outperform their counterparts by gaining

deeper insights into customer preferences, competitors, and distribution channels (Chong *et al.*, 2018). Furthermore, effective market strategy empowers an organizations to outperform competitors by fostering stronger customer relationships and driving positive performance outcomes such as increased sales, market share, and profitability (Morales Mediano and Ruiz-Alba, 2020).

However, Firm performance is gauged by the extent of its achievements, including profits, market share growth, sales performance, and strategic objectives attainment. Moreover, market orientation significantly contributes to firm performance by instilling behaviours conducive to maximizing customer value (Alt *et al.*, 2019). More so, Challenges persist in the poultry production sector in Minna metropolis. These challenges have slowed down the rate of production in the industry. This was due to supply of poor quality chicks, most farmers do not have an idea of the farms that hatch the chicks they buy, as they buy from road side hawker, mortality mostly occur at brooding stage, High cost of poultry feeds was identified, Inadequate poultry extension services, Lack of technical knowledge and high cost of Veterinary services is another major challenge posing a trait to the industry (Al-Hakimi *et al.*, 2023).

Managers in such industries must possess profound market orientation knowledge to swiftly adapt to market dynamics and continually enhance firm performance (Murtiniet *al.*, 2022). It is against this backdrop, that this study aims to examine the effect of market orientation on performance of poultry businesses in Minna Metropolis, Niger State, Nigeria.

2.0 Literature Review

2.1 Market Orientation

According to Moellering (2019) defines market orientation as the comprehensive gathering of market intelligence concerning present and future customer needs throughout an organization, followed by the dissemination of this intelligence across departments and a company-wide responsiveness to market trends. More so, Savabieh *et al.*, (2020) noted that market orientation influences a company's ability to obtain and act upon feedback from both customers and competitors, emphasizing the importance of specific processes that consistently deliver superior value to customers. Furthermore, Dwyer, (2022) asserted that

market orientation is instrumental in helping firms achieve sustainable competitive advantage.

Torres *et al.*, (2021) defines market orientation as the organizational culture that firms most imbibe in order to create superior value for buyers, thereby driving continuous superior performance for their business. This definition identifies four key behavioral components of market orientation: customer orientation, competitor orientation, E-market orientation and entrepreneur orientation. Managers, as highlighted by Al Asheq *et al.* (2021), require deep market knowledge to promptly respond to market dynamics and continually enhance firm performance, making it challenging for competitors to replicate market orientation due to the presence of firm-specific information and strategic management.

However, Firms embracing market orientation outperform their counterparts by gaining deeper insights into customer preferences, competitors, and distribution channels. Market orientation, coupled with market capabilities, empowers organizations to outperform competitors by fostering stronger customer relationships and driving positive performance outcomes such as increased sales, market share, and profitability (Savabieh *et al.*, 2020; Dwyer, 2022).

Nevertheless, market orientation, as characterized by Widayatiet *al.* (2023), is the degree to which an organization acquires and utilizes customer information to develop and execute strategies that meet customer needs and desires. This concept is also viewed as an internal driving force that shapes market actions and influences the relationship between employees and customers (Hoang and Bui Thanh, 2021). The significance of market orientation in driving organizational actions and performance is emphasized by Hari Adi and Adawiyah (2018), with researchers such as Chong *et al.* (2018) and Dwyer, (2022) highlighting its importance as a precursor to high performance, facilitating growth through the development of trust with stakeholders and an integrated market approach.

Conversely, market orientation is indispensable for businesses as it aligns strategies with customer needs and market trends, facilitating long-term success (Motsepe, 2019). By prioritizing understanding and meeting customer needs, businesses can tailor products and services to enhance customer satisfaction and loyalty (Tehci and Şenbursa, 2021). Moreover, businesses with a strong market orientation can differentiate themselves from competitors by consistently delivering superior value and fostering a culture of innovation (Murtiniet *al.*,

2022). This customer-centric approach contributes to long-term profitability by cultivating customer loyalty and advocacy, driving increased sales and revenue (Hamzah *et al.*, 2023).

In this study, market orientation is conceptualized based on four components: customer orientation, competitor orientation, E-market orientation, and entrepreneur orientation, positing that adherence to these components promotes performance and productivity. Overall, market orientation is essential for businesses to thrive in today's competitive landscape, enabling them to create value, drive growth, and achieve sustainable success by placing the customer at the forefront of their strategies.

2.1.2 Dimension of market orientation

2.1.2.1 Customer orientation

According to Mahmutovic (2021), market orientation involves identifying the targeted consumers, understanding their needs, and efficiently utilizing company resources to meet those needs through strategic development. Customer orientation, as highlighted by Reimann *et al.* (2022), focuses on thoroughly understanding target customers to provide superior value, necessitating a comprehensive grasp of buyers' entire value chain. Nuryakin and Maryati (2022) emphasize that market customer orientation requires access to various types of information about customers' current and latent needs, as well as the factors affecting their fulfillment. Ipek and Bıçakcıoğlu-Peynirci, (2020) suggests that once this information is available, mobilizing company-wide efforts to satisfy customers' needs becomes paramount, making the availability of customer needs information a significant aspect of market orientation (Adams *et al.*, 2019).

Similarly, Crick *et al.* (2021) define a customer-oriented firm as one capable and willing to identify, analyze, understand, and respond to customers' expressed needs, emphasizing the importance of listening to customer feedback to deliver superior value (Cuevas-Vargas *et al.*, 2022). This orientation prioritizes customer interests and beliefs, as outlined by Chang *et al.* (2018). Gathering customer intelligence is crucial for firms adopting a customer orientation, enabling them to gather information directly from customers through preference and behavior analysis and customer satisfaction surveys.

Without a doubt, senior managers' commitment to market orientation and their understanding of the role of market information are vital for strategy formulation and implementation,

involving active participation and commitment from staff across the organization (Crick, 2021). Gathering technological intelligence is also crucial, requiring both formal processes and informal systems involving employees and senior managers (Saleh *et al.*, 2021). The ability to access and integrate knowledge from various sources fosters problem-solving discussions and innovation within the organization (Nwekeala and Opara, 2023).

Similarly, Customer orientation in market orientation, is indispensable for businesses for several reasons. By prioritizing understanding and fulfilling customer needs, businesses can enhance satisfaction, differentiate themselves from competitors, foster strong relationships, and ultimately drive profitability and growth (Mařík *et al.*, 2022; Royo-Vela *et al.*, 2022; Ikramuddin *et al.*, 2021). Furthermore, actively listening to customers and adapting to their feedback enables businesses to make data-driven improvements, remain adaptable to market changes, and ensure long-term success (Riswanto *et al.*, 2019; Mehralian, 2022; Shaukat and Ming, 2022). Therefore, in this study, customer orientation is conceptualized as a factor that enhances firm business performance through understanding customer's needs.

2.1.2.2 Competitor orientation

Competitor orientation emphasizes understanding of the strengths and weaknesses of existing and potential competitors and at the same time monitoring competitor behaviors in order to meet the latent and potential needs of the target customer (Omar *et al.*, 2022). Muya and Tundui, (2023) suggests that to understand current and potential competitors, a firm can assess its position, develop appropriate strategies, and respond quickly to competitors' actions with prompt precise actions in the short run and at the same time modify market programmes in the long run. They noted that the capabilities arising from a market orientation enable the business to identify and exploit discontinuities in its current markets as well as un-served markets. As a form of business culture, a market orientation is difficult for competitors to observe and understand, much less to imitate and, thus, is a competitive advantage (El Manzani, 2021). Therefore, a business's opportunities for success will be maximized when all organizational members recognize that they can contribute to create buyer value and are motivated and empowered to do so.

Similarly, Suleiman *et al.*, (2022) noted that for a company to gain sustained advantages over competitors it is not enough to collect market intelligence and share it throughout the company. What is needed is an organization's effective response capability based on

intelligence and knowledge. They note that customer orientation need not necessarily result in customer response capability if the propensity to respond is not matched by the corresponding ability to respond. It can be concluded that the market orientation effect is determined by the company's customer response capability and vice versa.

Therefore, Peterson and Crittenden (2020) opined that inter-sectorial coordination that the coordinated use of company resources to create superior value for customers. So anyone in the company could potentially contribute to create value for the buyer. This integration of business resources is synchronized in line with customer-orientation and competitor-orientation. Using the information produced in two parts, customer orientation and competitor-oriented and dissemination of information throughout the fabric of the organization, the coordination of corporate resources is possible.

However, Competitor orientation enables businesses to benchmark their performance against industry peers. By comparing key performance indicators such as market share, profitability, and customer satisfaction with competitors, businesses can assess their relative strengths and weaknesses and identify areas for improvement (Al Asheq *et al.*, 2021). By monitoring competitors, businesses can identify potential risks and threats to their market position and take proactive measures to mitigate them. This may include diversifying product offerings, strengthening customer relationships, or investing in defensive market tactics to protect market share. Studying competitors can provide valuable insights into customer preferences, behaviors, and trends. By analyzing competitor customer bases and feedback, businesses can gain a deeper understanding of market needs and preferences, informing product development and market strategies (Widayatiet *al.*, 2023).

In conclusion, Competition often drives innovation as businesses seek to differentiate themselves and gain a competitive advantage (Hoang and Bui Thanh, (2021). By monitoring competitor innovations and industry trends, businesses can identify opportunities for product or service improvements, process enhancements, or disruptive innovations that can drive growth and market leadership. Overall, competitor orientation is important for businesses to stay competitive, anticipate market changes, identify growth opportunities, and make informed strategic decisions that drive long-term success and profitability. In this study, competitor orientation is conceptualized as a factor fostering firm business performance through understanding the strength and weakness of your competitor.

2.1.2.3 *E-market orientation*

The significance of e-market is expanding rapidly, playing a pivotal role in the success of firms across various sectors within the business environment. E-market involves leveraging information and communication technologies to achieve market objectives strategically (Yousef *et al.*, 2018). Al Asheq *et al.* (2021) define e-market as the use of the internet and interactive technologies to facilitate communication between firms and identified customers, essentially supplementing traditional online and digital market activities. The adoption of e-market activities is poised to minimize costs and enhance reach to a larger customer base.

Undoubtedly, Murtini *et al.* (2022) indicate that market activities, coupled with internet alignment, may indirectly influence firm performance through market orientation. Integration of the internet facilitates transaction-oriented business activities such as order placement and payment settlement, thereby enhancing firm performance (Hamzah *et al.*, 2023). In the digital age, e-market orientation, also known as digital market orientation, is crucial for businesses to reach a global audience efficiently and cost-effectively.

As a result, e-market orientation is essential for businesses to leverage digital channels effectively, reach a global audience, personalize market efforts, engage customers, gain a competitive edge, and drive growth in the digital age. Thus, this study views E-market as an essential catalyst for firm business performance through the use of information and communication technology.

2.1.2.4 *Entrepreneur orientation*

Entrepreneurial orientation encompasses the processes, practices, and decision-making activities that drive entrepreneurial decisions and actions within an organization (Adams *et al.*, 2019). Characteristics associated with entrepreneurial orientation include autonomy, innovativeness, risk-taking, pro-activeness, and competitive aggressiveness (Crick *et al.*, 2021). These dimensions can be defined as follows: competitive aggressiveness involves adopting a combative stance towards rivals and employing high levels of competitive intensity to surpass them; innovativeness entails embracing creativity, experimentation, and technological leadership in products and processes; pro-activeness relates to forward-looking efforts to shape the environment by introducing new products or processes ahead of the competition; risk-taking involves committing resources to projects with uncertain outcomes and entering unknown markets; and autonomy refers to actions aimed at establishing new business concepts, ideas, or visions.

In the same way, entrepreneurial orientation influences strategic decision-making and is positively related to firm performance (Chang *et al.*, 2018; Cuevas-Vargas *et al.*, 2022). The adoption of a brand orientation is considered an entrepreneurial activity (Somjai and Sangperm, 2019; Nuseir and Aljumah, 2022), but it is a resource-intensive process with significant opportunity costs (Pratama and Adhitya, 2021). Managers must be willing to take risks, be proactive, and engage in innovative activities to be successful, adopting an entrepreneurial orientation (Saleh *et al.*, 2021). Entrepreneurial orientation enables firms to develop innovation capabilities and identify new opportunities more easily than firms with lower levels of entrepreneurial orientation (Yousef *et al.*, 2018).

Consequently, Entrepreneurial orientation combines market orientation and entrepreneurial orientation as crucial for overcoming resource disadvantages and amplifying the benefits of both orientations (Nwekeala and Opara, 2023). By engaging in entrepreneurial market behaviours, businesses can create customer value, develop new goods and services, pursue new opportunities, and enhance their economies of scale (Crick *et al.*, 2021). Entrepreneurial orientation encourages businesses to innovate, think creatively, and prioritize customer needs, fostering loyalty and driving satisfaction and retention (Hamzah *et al.*, 2023).

In the same way, Entrepreneurs are agile, adaptable, and willing to take calculated risks, enabling them to navigate uncertainty and capitalize on emerging opportunities (Hari Adi and Adawiyah, 2018). Resilience and perseverance are essential for overcoming setbacks and failures, ensuring long-term success and sustainability (Crick *et al.*, 2021). Overall, entrepreneurial orientation is vital for fostering innovation, adaptability, risk-taking, and proactiveness, essential traits for success in today's dynamic and competitive business landscape. Therefore, in this study, entrepreneur orientation is going to be conceptualized in the study as innovativeness.

2.1.3 Performance

Performance is defined as the level of achievement attained by an enterprise, typically expressed through metrics such as profit growth, market share, sales achievement, and strategic objectives (Mehrez *et al.*, 2021; Al Naqbiaet *al.*, 2020). Scholars have discussed performance from various perspectives and orientations (Ilham, 2018; Guterresaet *al.*, 2020), with recent research indicating that the relationship between market orientation and firm performance remains robust regardless of the external environment (Tajvidi and Karami,

2021). Market-oriented strategies enable firms to adapt successfully to external changes by gathering market feedback and responding innovatively (Ilham, 2018; Boiko, 2022).

Performance assessment encompasses both financial and non-financial measures, with financial measures relying on monetary instruments to evaluate overall firm outcomes (Sri-Guru and Jaskaran, 2014). Objective financial measures include indicators like return on assets, operating income, profit levels, return on investment, and market share, often derived from secondary data or subjective perceptions gathered from managers, customers, and stakeholders (Pucheta-Martínez and Gallego-Álvarez, 2020; Dewi, 2020).

Non-financial measures, on the other hand, utilize non-monetary instruments to assess firm performance, often influencing financial measures despite lacking direct financial attributes (Al Naqbiaet *al.*, 2020). These measures include indicators such as increased in volume of output, increased sales output, employee satisfaction, service quality, and productivity, as perceived by departmental managers and stakeholders (Al Naqbiaet *al.*, 2020; Khan *et al.*, 2018).

For this study, non-financial performance measures based on increased in volume of output were chosen, as they are considered primary indicators affecting financial measures without direct financial attributes (Dewi, 2020). This approach aligns with the understanding that non-financial measures play a crucial role in shaping overall firm performance, alongside financial metrics. For the purpose of this study, poultry business performance will be conceptualized in term of increase in volume of output. The rational for the selection is based on the fact that the goal of an organization can only be achieve if a business firm is market oriented.

3.0 Conceptual Framework

The conceptual framework outlines the independent and dependent variables as discussed in the literature review and elaborated in the figure 1.0 below

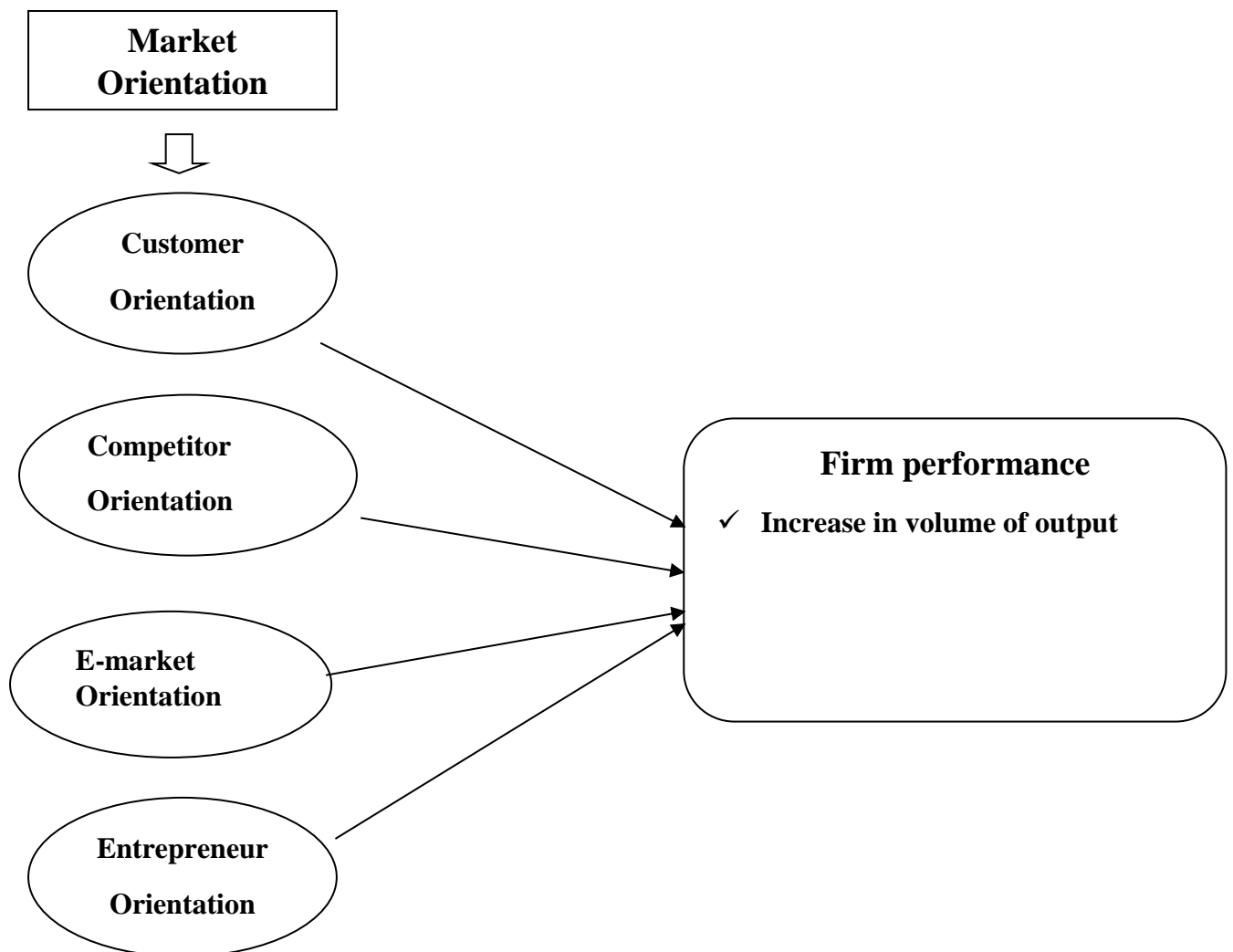


Figure 1.0 –social capital

Source: authors (2020)

It can be observed from Figure 1.0 that this study expects the respondents' perception about market orientation in terms of customer orientation, competitor orientation-market orientation and entrepreneur orientation to determine their overall level of business firm performance.

4.0 Market Orientation Theory

Narver and Slater, are often credited with popularizing the concept of market orientation in the academic literature through their seminal work published in the Journal of Market in 1990. In their paper titled "The Effect of Market Orientation on Business Profitability," Narver and Slater defined market orientation as the organizational culture that emphasizes the importance of continuously gathering and disseminating information about customers and competitors, and using this information to create superior value for customers (Voges and glaser-segura, 2016). According to Lloyd (1996) posit that market orientation theory is a strategic approach that emphasizes the importance of focusing on customers and markets in guiding a company's actions and decisions. It is based on the belief that understanding and satisfying customer needs and preferences is essential for achieving long-term success and competitiveness in the marketplace. At its core, market orientation theory suggests that companies should:

- i. **Gather Market Intelligence:** Continuously collect information about customers, competitors, and the overall market environment. This includes understanding customer needs, preferences, and behaviours, as well as monitoring competitor actions and market trends.
- ii. **Disseminate Intelligence Internally:** Share market intelligence throughout the organization, ensuring that all departments and employees are informed about customer insights and market dynamics. This helps align the entire organization towards a customer-centric mind-set.
- iii. **Respond to Market Intelligence:** Use the gathered intelligence to make informed decisions and take actions that are responsive to customer needs and market trends. This may involve developing new products or services, adjusting pricing strategies, or refining market tactics.
- iv. **Create Superior Value for Customers:** Focus on delivering superior value to customers by offering products or services that meet their needs and preferences better than competitors. This may involve innovation, quality improvements, or personalized customer

experiences. Market orientation theory suggests that companies that adopt a market-oriented approach are better positioned to adapt to changing market conditions, anticipate customer needs, and maintain a competitive advantage over time. By placing customers at the center of their strategies, these companies are more likely to achieve sustainable growth and profitability in the long run.

Critics argue that market orientation theory often focuses on understanding and responding to current customer needs, rather than providing strategic guidance for long-term success. Some argue that market orientation may lead firms to be reactive rather than proactive in anticipating future market trends and opportunities.

4.2 Theory selection process for the study

As earlier explained in this paper, market orientation was conceptualized based on four generic strategies of Torres *et al.*, (2021) that are the fundamental basics that an organization needs in improving business firm performance; customer, competitor, E-market and entrepreneur. Using this conceptualization as bedrock, the theory that is most suitable for the context of this study will be the one that most excellently elucidate the impact of the four market orientation components on business performance. A detailed examination of each of the three theories showed that market orientation theory most excellently meet this requirement.

Market orientation theory best suit the context of this study as it explicitly looks comprehensively for reasons that are liable for a firm business performance through customer. Market orientation theory provides insights into the processes, practices, and organizational culture necessary to effectively identify, understand, and respond to customer needs and preferences. In conclusion, to understand the impact of market orientation on business firm performance, this study adopts market orientation theory as its theoretical background.

5.0 Limitation and Future Research Direction.

The current study has some limitation: limited sample sizes and are restricted to specific geographical areas, making it difficult to generalize findings globally, consistent data can be a significant limitation. Many poultry businesses, especially smaller or family-owned operations, may not maintain detailed records or may be reluctant to share sensitive business

information. By addressing these limitations and pursuing these research directions, future studies can provide more comprehensive and actionable insights into the relationship between market orientation and performance in the poultry business.

6.0 Conclusion and Recommendation.

The relationship between market orientation and performance in the poultry business is critical for achieving competitive advantage and long-term success. Market orientation, characterized by a strong focus on customer needs, competitor strategies, and inter-functional coordination, has been shown to positively influence various performance metrics, including financial outcomes, customer satisfaction, and operational efficiency. However, the degree of impact can vary based on factors such as market conditions, technological adoption, and regulatory environments.

Studies indicate that poultry businesses with a high degree of market orientation are better positioned to adapt to market changes, innovate effectively, and meet consumer demands. Despite the demonstrated benefits, the extent of market orientation's impact can be influenced by limitations such as sample size, data quality, and the rapidly changing dynamics of the poultry industry. It is recommended that poultry businesses should invest in robust data collection and analysis systems to better understand market trends, customer preferences, and competitor strategies. Utilizing advanced data analytics can provide deeper insights and support more informed decision-making.

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**ASSESSMENT OF AGILE PROJECT MANAGEMENT ADOPTION IN
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ABSTRACT

Given the dynamic landscape of Information Technology (IT), the pursuit of effective project management methodologies has become a paramount concern for organizations seeking to enhance their project delivery capabilities. Among the myriad of methodologies, Agile Project Management has emerged as a transformative approach, emphasizing flexibility, collaboration, and iterative development. As the Nigerian IT sector continues to embrace innovative solutions and responds to the challenges of a rapidly changing technological environment, the adoption of Agile practices holds significant promise. This study assessed agile project management adoption rate in IT project performance in Nigeria. Questionnaires were administered to 77 project managers who have worked on IT projects in Nigeria. Descriptive analysis was used to analyze the data collected. Results revealed that about 79.2% of the respondents uses Agile project management in the execution of IT projects in Nigeria and 81.2% of the 16 respondents who are yet to adopt Agile Project management admitted that they will adopt it in the future. Findings further showed that Scrum Agile methodology was the predominantly used agile methodology in the execution of IT projects in Nigeria.

Keywords: Agile, Project Management, Adoption, Information Technology, Nigeria**1.0 Introduction**

In the ever-evolving landscape of Information Technology (IT), the dynamic nature of projects demands nimble and adaptive methodologies to ensure successful and timely outcomes. The essentiality of meeting clients' needs underscores the importance for project managers overseeing projects to employ optimal strategies. However, this can prove challenging for project managers, given the intricate nature of IT projects which entail significant risks, and most times constrained by both time and budget (Esangbedo and Ealefoh, 2021). Businesses in various sectors have adopted Agile methodologies as a strategy to improve project results, promote customer satisfaction, and optimize the allocation of resources (Ghimire and Charters, 2022). As organizations in Nigeria strive to harness the potential of IT projects to drive innovation and meet market demands, the adoption of Agile Project Management emerges as a pivotal consideration. Agile Project Management, originating from the software development realm, has grown into a holistic approach

embraced by diverse industries worldwide. Its core principles of flexibility, collaboration, and iterative development align seamlessly with the fast-paced and evolving nature of IT projects (Chathuranga *et al.*, 2023). As Nigeria positions itself as a hub for technological advancements and digital transformation, understanding the nuances of Agile adoption becomes essential for organizations striving to stay competitive in the global IT landscape.

The Nigerian IT sector has experienced significant growth, playing a pivotal role across various industries such as banking, healthcare, telecommunications, and e-commerce (Akenbor, 2020). IT usage has become ubiquitous globally, facilitating constant interaction and communication among individuals through various services (Roshan and Santhosh, 2021). Ensuring the effective completion of IT projects with a focus on quality assurance is imperative for organizations aiming to innovate, compete, meet customer demands, and contribute to economic growth (Sowunmi *et al.*, 2016). Agile methodologies present a unique opportunity to enhance project outcomes, address challenges, and cultivate adaptability in this context (Version One, 2021). Therefore, conducting research to assess Agile adoption rate in IT project in Nigeria holds significant importance, serving as a reference point for organizations seeking to improve project performance, particularly in areas such as product utilization, customer satisfaction, product quality, and team performance.

In recent times, organizations have been attracted to the agile development methodology's ability to engage stakeholders, adapt to evolving needs, and deliver software rapidly (Cram, 2019). Agile has been widely adopted across various industries as a means to improve project outcomes, enhance customer satisfaction, and optimize resource allocation (Highsmith, 2002; Ghimire and Charters, 2022). According to a recent report by Version One (2021), organizations adopt agile primarily for faster project delivery (64%), better management of changing priorities (64%), increased team productivity (47%), and cost reduction (23%). Additionally, research by Ghimire and Charters (2022) indicates that commonly used agile practices such as User stories, Burndown/Burnup charts, pair programming, epics, and stand-ups significantly impact team communication, project requirements, and priorities in Agile software development teams. In addition, research conducted by Mary and Nkiru (2017) focusing on Nigerian Practitioners' Perspectives of the Agile Methodology in Software Project Management indicates that scrum emerges as the predominant agile methodology, utilized by 38% of the respondents for software development. The study identifies two primary challenges hindering the adoption of Agile methodologies: 32% of respondents cited

cost constraints, while 28% reported insufficient team support (Mary and Nkiru, 2017). However, this study did not assess Agile project management adoption rate in the execution of IT projects.

Several studies, including those by Roshan and Santhosh (2021), Fontana and Marczak (2020), and Azanha *et al.* (2017), have demonstrated the effectiveness of agile methodology in enhancing the performance of IT projects. However, research by Version One (2021) suggests that skepticism and resistance toward agile adoption exist within some IT organizations. Despite the wealth of research focusing on traditional project constraints like scope, time, and cost, Kandengwa and Khoza (2021) highlight the importance of measuring project success based on business value, project visibility, and process improvement, with customer satisfaction emerging as a critical metric. While previous studies have explored alternative metrics for evaluating project performance, none have specifically examined the rate of agile adoption in the execution of IT projects. This paper assesses the rate of agile adoption in the execution of IT projects in Nigeria as well as the prevailing agile methods, practices and tools used in IT project delivery in Nigeria.

2.0 Literature Review

The introduction of Agile methodologies into conventional project management practices marks a fundamental change in approach, challenging traditional methods and promoting a culture centered on adaptability and ongoing enhancement. The global landscape of project management has witnessed a profound shift with the advent of Agile methodologies, particularly in the dynamic realm of Information Technology (IT). As organizations worldwide embrace the need for increased flexibility, collaboration, and rapid response to changing requirements, the adoption of Agile Project Management has become a crucial determinant of project success.

2.1 Agile Project Management

Agile project management represents an iterative approach prioritizing customer value, interaction over rigid task structures, and adaptability to current business dynamics rather than strictly adhering to predetermined plans (Conforto, *et al.*, 2016). The agile methodology involves breaking down large, intricate deliverables into smaller, incremental releases to solicit feedback from project clients, integrating their experiences and allowing their influence over project development while maintaining control and structure (Revutska and Antlová, 2022). Recognized for its speed, proactive nature, flexibility, and responsiveness to

change, agile project management systems enhance the ability to swiftly respond to site changes, minimizing the interval between risk detection and corrective action (Daneshgari and Daneshgari, 2010).

2.2 Agile Project Management Principles

The foundational principles of Agile, as outlined in the Agile Manifesto, emphasize customer collaboration, responding to change, and delivering working solutions iteratively. Research by Beck *et al.* (2001) and Schwaber and Sutherland (2017) highlight the significance of these principles in enhancing project adaptability and customer satisfaction. These principles form the backbone of Agile methodologies and set the stage for their application in various project environments. Also, comparing between Agile principle and other project management methodologies, Juricek (2014) concludes that Agile project management ensure project instructions are clear, project practice are clearly functioning, improvement in project visibility, adaptability and business value, while reducing the risks in project execution. These methods were compared based on active user involvement, team management, flow requirements, iteration, testing, and stakeholders' collaboration. Agile principles main focus is to deliver software that meet customer needs and preferences frequently; accommodate modification request from the customer; and delivers working software with every release. It also facilitates healthy interaction among the project stakeholders while providing individuals with the environment and support needed (Ceschi *et al.*, 2005; Port & Bui, 2009; Juricek, 2014).

2.3 Agile Methods, Practices and Tools

Agile Methods:

The Agile Manifesto, conceived approximately 17 years ago, aimed to revolutionize software product delivery by eliminating bureaucracy and emphasizing value delivery, as stated by Arie van Bennekum, a founding partner of the manifesto (Hohl et al., 2018). Influential methodologies that influenced the manifesto's development include *Scrum*, *Crystal*, *Dynamic Software Development Method (DSDM)*, *Test Driven Development (TDD)*, *Feature-driven development (FDD)*, *Extreme Programming (XP)*, among others (Hohl et al., 2018). Over time, additional methodologies such as *Lean*, *Kanban*, and *hybrid methods like Scrumban* have been introduced and widely adopted, expanding the spectrum of agile practices (Version One, 2021).

Scrum emerges as one of the most widely embraced agile methodologies, particularly favored among IT companies for project delivery (Hron and Obwegeser, 2018). Crystal Methodologies promote a team-based approach to software development, offering flexibility in methodology selection to adapt to varying project requirements (Cockburn, 2002). Dynamic Software Development Method (DSDM) emphasizes quality product delivery within defined timeframes and budgets, often complementing other agile methodologies (Carroll and Morris, 2017). Feature-driven development (FDD) focuses on iterative software delivery that meets customer needs within set timeframes, employing technical practices like continuous integration and deployment (Carroll and Morris, 2017).

Kanban, derived from the Toyota production system, aims to enhance system flow and throughput by minimizing waste and optimizing workflow (Layton, 2020). Lean principles, rooted in effective manufacturing processes and waste reduction, have gained global recognition across various industries, including healthcare, IT, and education, by emphasizing customer value and quality improvement (Melović et al., 2016). The effective adoption of Lean practices is facilitated by management buy-in, comprehensive training, and a focus on customer satisfaction (Demirkesen and Bayhan, 2019).

Agile Practices:

Fontana and Marczak's (2020) recent study on agile software development adoption in the Brazilian public sector highlights *Standup meetings* and *Kanban* as the most prevalent agile practices. Standup meetings serve as an effective tool for identifying potential project hazards and fostering continuous monitoring and management of risks and opportunities. Retrospectives, emphasizing lessons learned at the end of each iteration, rank as the second most prevalent agile practice, according to Version One's report (2021). *Sprint/Iteration Planning*, *Sprint/Iteration Review*, and the use of *Kanban Boards* are underscored as vital components of agile project management, with Kanban emerging as the most popularly used agile practice in Brazil's government organizations (Fontana and Marczak, 2020). Additionally, *Release Planning*, *Product Backlog*, and *User Story Mapping* are essential elements in agile methodologies, ensuring efficient workflow management and alignment with project objectives and stakeholder expectations (Project Management Institute, 2021; Larson and Grey, 2021).

Agile Tools:

Agile tools encompass software programs and online computing platforms designed to facilitate and bolster Agile project management methodologies. These technologies enable Agile teams to efficiently strategize, track development progress, foster collaboration, and oversee project management tasks. As per the State of Agile report by Version One (2021), while Kanban boards, task boards, and spreadsheets are commonly utilized Agile tools, respondents predominantly recommended Atlassian Jira, Digital.ai Agility, and Azure DevOps as the most effective tools for Agile project management.

2.4 Agile Project Management Adoption in Nigeria

Agile methodologies have gained traction globally, particularly in IT projects where rapid development and responsiveness are critical. A study by Ambler and Lines (2012) examines the state of Agile adoption across various industries, underscoring its widespread acceptance and positive impact on project outcomes. This global perspective provides a contextual backdrop for understanding Agile adoption trends in the Nigerian IT landscape. The adoption of agile methodologies in Nigeria has witnessed a significant rise in recent years, driven by the need for improved project management in response to changing business dynamics (Akinsola et al., 2021). Scrum and Kanban have gained popularity in the Nigerian IT sector, aiding collaboration, adaptability to changing needs, and the delivery of value to consumers (Akinsola et al., 2021).

Various sectors in Nigeria, including banking, telecommunications, healthcare, e-commerce, energy, utilities, and manufacturing, are increasingly embracing agile methodologies to expedite processes and stay competitive (Oludare and Ajagbe, 2021; Yahaya et al., 2018; Ademola et al., 2021; Onuigbo et al., 2020; Olayiwola et al., 2017; Ezenwoko et al., 2018). Agile principles facilitate quicker project delivery, making them suitable for Nigeria's rapidly evolving business environment (Kolawole & Oluwafemi, 2019). Increased awareness and comprehension of agile practices among IT professionals and organizations also contribute to the rising adoption of agile methodologies in Nigeria (Iroh and Nwala, 2018). Agile training and certification programs play a crucial role in equipping professionals with the necessary skills and certifications to support agile implementation (Iroh and Nwala, 2018).

Despite the growing usage of agile practices, several obstacles hinder their broader acceptance in Nigerian organizations, including resistance to change, lack of knowledge and training, and the necessity for cultural transformation (Adekunle & Adeniran, 2021). These

challenges underscore the importance of addressing organizational barriers and fostering a conducive environment for agile adoption to thrive in Nigeria.

2.5 Challenges of Agile Project Management Adoption

While Agile offers numerous advantages, its adoption is not without challenges. Challenges persist in adhering to agile principles and practices, hindering optimal outcomes (Rigby, Sutherland, and Takeuchi, 2017). Inconsistent processes and practices across teams emerge as the most significant challenge faced by organizations adopting the agile methodology (Version One, 2021). Also, research by Conboy and Fitzgerald (2004) identifies challenges such as organizational resistance, cultural shifts, and the need for skilled practitioners. These challenges are likely to resonate within the Nigerian context, where organizational structures and cultural dynamics may influence the successful implementation of Agile practices.

Large-scale project initiatives struggle with the integration of agile methodologies due to their complexity and extensive collaboration requirements (Dikert *et al.*, 2016). While Agile has proven to enhance project performance, large-scale transformations entail complexities, high costs, and significant risks (Van Haaster, 2016). Overcoming integration challenges necessitates implementing hub structures with overlapping roles and responsibilities to effectively manage large projects (Larson and Grey, 2018). In spite of the benefits of agile project management, such as improved stakeholder quality and customer satisfaction, issues with teamwork and coordination persist (Esangbedo and Ealefoh, 2021). Agile project management presents difficulties for top management in controlling project budgets and deadlines due to evolving customer needs (Larson and Grey, 2018). Inadequately defined scopes and scope creep contribute to project failures, emphasizing the importance of requirement engineering in software development (Amjad *et al.*, 2018; Rasheed *et al.*, 2021).

Organizational resistance to change poses a significant hurdle to agile methodology adoption, with traditional waterfall models preferred due to familiarity and ease of implementation (Version One, 2021; Mahanti, 2006). Additionally, customer engagement challenges arise when obtaining feedback for updated requirements, leading to project failures (Sithambaram *et al.*, 2021). However, the applicability of Agile methodologies in developing economies, such as Nigeria, introduces unique considerations. A study by Nawrocki and Wojciechowski (2016) explores the challenges and opportunities of Agile adoption in a developing economy context.

2.6 The Nigerian IT Industry

The information technology (IT) sector in Nigeria has undergone rapid growth due to increased internet accessibility, digital infrastructure enhancements, and a young, tech-savvy population (PWC, 2020; Ekwealor, 2020). Being the largest economy in Africa, Nigeria offers a substantial market for IT products and services, encompassing software development, hardware, telecoms, and IT services. Software development has emerged as a key focus within the industry, covering services such as custom programming, app development, fintech solutions, e-commerce platforms, and business digitalization (Ogunyemi *et al.*, 2018). Multinational companies are drawn to Nigeria, attracted by the availability of skilled labor at competitive costs.

Despite contributing approximately 14% to Nigeria's GDP in 2020, driven by fintech, e-commerce, and the digital economy, the IT industry faces challenges. These include poor infrastructure, skill gaps in emerging technologies, challenging business conditions, limited government policy support, restricted finance access for startups, and cybersecurity threats (Ekwealor, 2020; Ogunyemi *et al.*, 2018). The industry, while showing pockets of advancement, remains in a developing phase. Agile project management techniques can assist Nigerian IT companies in handling frequent changes, unclear requirements, tight deadlines, and innovation pressures. Although awareness of agile methods is high, adoption is still emerging, necessitating research on its impact on IT project performance in Nigeria. Unlike previous global studies focusing on the triple constraint, this research emphasizes product quality based on releasable features and value delivered to customers and team performance. Successful adoption of agile methodologies is anticipated to positively impact the Nigerian IT industry and the overall economy.

3.0 Methods and Procedures

The study employed a descriptive research design to ascertain the prevalence of agile methodology within the Nigerian IT industry. This involved assessing the adoption rate of agile methodology, as well as the tools, methods, and practices currently utilized in Nigeria. The sampling population consisted of all product managers in Nigeria with expertise in IT project management. These individuals were chosen based on their firsthand experience in planning and leading project initiatives (Pilkington, 2016). A convenience sampling

technique (Etikanet *al.*, 2016) was utilized to select one hundred (100) IT product managers in Nigeria. Structured questionnaires were administered to gather data on the adoption rate of Agile project management. The questionnaire comprised closed-ended and Likert-scale questions addressing agile adoption, tools, methods, and practices used by Nigerian organizations for IT project delivery. Prior to distribution to the larger sample, a pilot testing was conducted on a smaller sample to ensure questionnaire validity and reliability based on feedback (Van Teijlingen& Hundley, 2001).

Data collected were analyzed using the Statistical Package for the Social Sciences (SPSS), known for its user-friendly interface and ability to handle large datasets (Pallant, 2016). Descriptive statistics such as mean and standard deviation were employed to summarize and analyze the data regarding the extent of Agile adoption in the Nigerian IT industry. Descriptive analysis was utilized to examine agile tools, practices, and methods to determine the extent of agile adoption in Nigeria. Additionally, descriptive statistics were used to establish the reasons for adopting Agile in the Nigerian IT industry. For interval data, means, ranges, and standard deviations were computed. Throughout the research procedure, ethical considerations were paramount. Informed consent was obtained from each participant, and data confidentiality was rigorously maintained.

4.0 Results and Discussion

This section shows the analysis of the data collected from the respondents (product managers) through the use of a structured questionnaire. Out of the 100 questionnaires distributed, about 84 questionnaires were retrieved which indicates about 84% response rate. However, only 77 questionnaires out of the 84 questionnaires retrieved were properly filled and this was used for the analysis of data.

4.1 Demographic information of respondents

Table 4.1 Work Experience of Respondents

Parameters	Classification	Frequency	Percentage
Number of years of experience of working on IT projects	Less than a year	9	11.7
	1-5 years	40	51.9
	6-10 years	19	24.7

More than 10 years	9	11.7
Total	77	100

Table 4.1 shows that majority (51.9%) of the respondents have 1-5years working experience. About 24.7% of the respondents have worked for about 6-10 years, 11.7% of them have less than one year working experience and 11.7% have worked for more than 10 years. This shows that most (88.3%) of the respondents had over 1 year experience of working on IT projects and about 36.4% of them had well over 5 years' experience which further gives more credence to their expertise in IT project management.

Table 4.2: Firm Size

Parameters	Classification	Frequency	Percentage
The size of your organization	< 50 employees	31	40.3
	50-200 employees	14	18.2
	201-500 employees	6	7.8
	> 500 employees	26	33.8
	Total	77	100

Table 4.2 indicates that 40.3% of the respondents work in organizations with less than 50 employees, 33.8% work in organizations with more than 500 employees, 18.2% work in organizations with a staff strength of 50-200 employees and lastly, 6% of the respondents work in organizations with 200-500 employees. This shows that majority (59.7%) of the respondents work in medium and large firms.

4.2 Agile Methodology Adoption

This section presents results on the agile methodology adoption, usage duration, types of agile methodology mostly used, predominantly used agile practices and techniques, and agile tools predominantly used in execution of IT projects in Nigeria. Also, reasons for adopting agile methodology and how the success of agile methodology is measured within the firms were considered.

Table 4.3: Firms use of Agile Project Management Methodologies

Parameters	Classification	Frequency	Percentage
Does your firm use Agile project management methodologies?	No	16	20.8
	Yes	61	79.2
	Total	77	100

As regards the use Agile project management methodologies, more than two-third (79.2%) actually use the Agile project management methodologies while 20.8% of the firms are yet to adopt the agile methodology in the execution of IT projects in Nigeria. This substantial adoption rate underscores the growing recognition of Agile methodologies as a suitable framework for managing IT projects in Nigeria. The result of this study is consistent with version one (2021), whose study revealed that 86% of software development teams have adopted agile in the development of their products which is a significant increase as compared to the percentage of software development teams that adopted the agile methodology in the delivery of their project in the previous year 2020 which stood at 37%. Another study by Akinsola *et al.*, (2021) further backed up the increase in the adoption rate of the agile methodology in IT project as the study confirmed that the adoption of the agile methodology has seen an increase in recent years due to the changing needs of customers.

Table 4.4: Firms plans to Adopt Agile Project management Methodologies in the future

Parameters	Classification	Frequency	Percentage
Your organization considering adopting Agile methodologies in the future	My organization has not adopted the agile methodology but will adopt it in the future	13	81.2
	My organization has no plans on adopting the agile methodology	3	18.8
	Total	16	100

Table 4.4 above shows that 81.2% of the firms that have not adopted the agile methodology are willing to adopt the agile methodology in the future while, the remaining 18.8% do not have plans to adopt the agile methodology in the future.

Table 4.5: Usage Duration of the Agile Methodology

Parameters	Classification	Frequency	Percentage
How long has your organization been using Agile methodologies?	Less than 1 year	6	10.0
	1-3 years	28	46.7
	More than 3 years	26	43.3
	Total	60	100

Table 4.5 revealed that 46.7% of the organizations have used Agile methodologies for between 1-3 years, while 43.3% others have used it for more than 3years, the remaining 10% only started using Agile methodologies less than a year ago.

Table 4.6: Mostly used Agile Methodologies in the Execution of IT Projects in Nigeria

Parameters	Classification	Frequency	Percentage
Which Agile methodology do you follow most closely in your organization?	Scrum	43	71.1
	Kanban	8	13.3
	Xtreme Programming (XP)	1	1.7
	Lean Development	2	3.3
	Iterative Development	5	8.3
	Scrum/XP hybrid	1	1.7
	Total	60	100

Table 4.6 indicates that about three-quarter (71.7%) of the organizations predominantly use the scrum Agile methodologies, followed by Kanban which accounts for 13.3%. others include Iterative development 8.3%, Lean Development 3.3%, Xtreme Programming (XP) and Scrum/ XP hybrid Accounting for 1.7% respectively. This finding resonates with the outcome of multiple research studies conducted both locally (Nigeria) and globally which confirms Scrum Agile methodology as the most widely used and most prevalent agile methodology (Mary and Nkiru, 2017; Hron and Obwegeser, 2018; Fontana and Marczak, 2020; Version one, 2021).

*Table 4.7: Predominantly used Agile Practices and Techniques in IT Projects ***

Agile Practices/Techniques	Responses	
	Frequency	Percentage
Daily Standup	53	13.9
Sprint/Iteration Planning	45	11.8
Product Road Mapping	42	11.0
Sprint/Iteration Reviews	41	10.8
Retrospectives	37	9.7
Release Planning	24	6.3
Story Mapping	22	5.8
Frequent Release	21	5.5
Agile/Lean UX	21	5.5
Kanban	15	3.9
Planning Poker/Team Estimation	15	3.9
Dedicated Customer/Product Owner	15	3.9
Short Iteration	7	1.8
Common Work Area	6	1.6
Agile Work Area	5	1.3

Others	5	1.3
Single Team	4	1.0
Agile Portfolio Planning	3	0.8
Total	381	100

** multiple response analysis

Table 4.7 reveals the three top rated techniques and practices employed/use by IT firms in Nigeria are Daily standup 13.9% closely followed by Sprint/Iteration planning 11.8%, Product Road mapping 11.0% while Sprint/iteration reviews was the 4th rated techniques employed. In all, Agile Portfolio planning was the least employed techniques and practices in the execution of IT projects in Nigeria. his result corroborates findings in the literature which confirms Daily standup as the most used agile practice in the delivery projects (Mkoba and Marnewick, 2020; Version One, 2021). Other widely used agile practices based on the study are sprint/iteration planning, product road mapping, sprint/iteration review, and retrospectives. On the contrary, research by Ghimire and Charters (2022), only agrees that the most widely used agile practice is daily standup, while the other 4 most widely used agile practices are user stories, Burndown chart/Burnup chart, pair programming, Epic and User stories.

*Table 4.8: Predominantly used Agile Tools in IT projects***

Agile Planning & Delivery Tools	Responses	
	Frequency	Percentage
Agile Project Management Tool	39	13.7
Product Road mapping	33	11.6
Wireframes	29	10.2
Bug Tracker	22	7.7

Kanban Board	21	7.4
Taskboard	17	6.0
Story Mapping Tool	17	6.0
Requirements Management Tool	14	4.9
Spreadsheet	13	4.6
Release/Deployment Automation Tool	10	3.5
Continuous Integration Tool	9	3.2
Automated Acceptance Test Tool	9	3.2
Others	9	3.2
Automated Build Tool	8	2.8
Unit Test Tool	8	2.8
Traditional Product Management Tool	7	2.5
Product and Portfolio Management (PPM) Tool	6	2.1
Wiki	4	1.4
Customer Idea Management Tool	4	1.4
Static Analysis	3	1.1
Timecards	2	0.7
Refactoring Tool	1	0.4
Total	285	100

** multiple response analysis

Table 4.8 shows that ranked first among Agile planning and delivery tools used in the execution of IT projects in Nigeria is the Agile Project Management Tool with a percentage of 13.7%, followed by Product Road mapping 11.6%, and Wireframes 10.2% while Refactoring Tool was the least employed with a percentage of 0.4%. This findings opposes a recent research that shows that Kanban board, taskboard, and spreadsheet are the most popularly used agile tools adopted by software development teams (Version one, 2021).

*Table 4.9: Reasons for Firms' Adoption of Agile Methodology ***

Reasons	Responses	
	Frequency	Percentage
Accelerate software delivery	49	13.0
Increase team productivity	45	11.9
Enhance ability to manage changing priorities	41	10.8
Improve business and IT alignment	35	9.3
Enhance software quality	30	7.9
Improve project visibility	29	7.7
Enhance delivery predictability	28	7.4
Reduce project risk	24	6.3
Better respond to volatile market conditions	20	5.3
Better manage distributed teams	20	5.3
Improve engineering discipline	19	5.0
Increase software maintainability	16	4.2
Improve team morale	14	3.7
Reduce project cost	7	1.9
Others	1	0.3
Total	378	100

** multiple response analysis

Table 4.9 indicates that the most important reasons for adopting agile within the team or organization was accelerate software delivery 13.0%, followed by increase team productivity

11.9%. Ranked third is enhance ability to manage changing priorities 10.8%. The least reported reason for agile adoption is reduce project cost at 1.9%.

*Table 4.10: Measurement of Agile delivery Success by Firms***

Success variables for Agile delivery	Responses	
	Frequency	Percentage
Business value delivered	33	11.9
Customer/user satisfaction	30	10.8
Customer retention	26	9.4
Planned vs. actual release dates	25	9.0
Product utilization	20	7.2
Budget vs. actual cost	18	6.5
Revenue sales impact	17	6.1
Burn-up chart	15	5.4
Planned vs. actual stories per iteration	13	4.7
Scope change in a release	13	4.7
Cycle time	12	4.3
Defects over time	12	4.3
Release burndown	12	4.3
Estimation accuracy	10	3.6
Iteration burndown	10	3.6
Cumulative flow chart	6	2.2
Individual hours per iteration/week	6	2.2
Total	278	100

** multiple response analysis

Table 4.10 revealed that Business value delivered (11.9%) ranked first among the ways IT project success is measured. This is closely followed by Customer/user satisfaction at 11.8% while Customer retention 9.4% ranked thirds and 4th was Planned vs. actual release dates. The least ranked amongst how IT projects success is being measures is individual hours per iteration/week at 2.2%. This finding corroborates with Dybå and Dingsøyr (2008) framework for evaluating the success of agile adoption which noted that factors such as customer satisfaction, team collaboration, and responsiveness to change as key parameters.

5.0 Conclusion

The result of the survey showed most of the respondents surveyed deploys agile project management in the execution of IT projects. Also, Scrum methodology was found to be the most prevalent agile methodology in the delivery of IT projects in Nigeria. Daily standup was revealed as the most predominantly used agile practice/technique in the delivery of IT projects. The three most predominantly used agile tools were; agile project management tool, product road mapping and wireframes. In addition, the three top reasons for the firms' adoption of agile project management were the need to; accelerate software delivery, increase team productivity and enhance ability to manage changing priorities. Also, agile delivery success measurement variables such as; business value delivered, customer/user satisfaction and customer retention respectively, were ranked as the top three by the respondents. This study concludes that agile project management is largely adopted in IT projects in Nigeria.

6.0 Recommendation

IT project managers and other project managers should be advised to engage in agile practices. The fact that agile methods is used extensively demonstrates that it satisfactorily meets the requirements of the target audience and offers value. This illustrates the fact the agile methodology is fulfilling both the expectations of its users as well as the purpose for which it was originally designed and this could possibly translate to higher return on investment.

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INFLUENCE OF ADOPTION OF NATURAL LANGUAGE PROCESSING ON CONSTRUCTION SITES MANAGEMENT IN ABUJA

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ABSTRACT

The increasing complexity and size of projects in the construction sector make it difficult to identify and verify initial requirements expressed in natural language. As a result, there are numerous errors and shortcomings in the definition of requirements at the early stages of concept and design, with inefficiencies in terms of time, cost and quality. Therefore, this study assessed the influence of the adoption of Natural Language Processing (NLP) on construction sites management in Abuja with a view to enhancing effective information management in construction projects. In order to achieve the aim, the study adopted a survey research design with the use of quantitative research approach. Data collection was undertaken with the use of structured questionnaires administered to eighty-five (85) construction professionals of Federal Capital Development Authority, Abuja. Analysis of data collected was done with the use of descriptive and inferential analytical techniques. Findings from the study revealed that the most significant drivers for the effective adoption of NLP for effective construction site management are "Efficiency" (RII = 0.83) and "Accuracy" (0.82); the most severe barriers to the effective adoption of NLP for effective construction site management are "Ambiguity" and "The manual

conformity control process is time-consuming, costly, and error-prone" ($RII = 0.74$ respectively); there exists a significant relationship between the adoption of NLP and construction sites management ($p = 0.001$; $r = 0.452$); and the most effective strategy for enhancing adoption of NLP for effective construction site management is "Allowing potential non-compliance cases to be identified in advance" ($RII = 0.80$). The study therefore concludes that the influence of the adoption of NLP on construction sites management in Abuja is very significant. It was recommended that the management of construction firms should develop a mechanism for enhancing the adoption of NLP for effective information management in construction projects by using the strategies developed in this study as a basis.

Keywords: Adoption; Construction sites; Influence; Information management; Natural Language Processing.

INTRODUCTION

The construction industry is well known for its fragmentation which dramatically affects two characteristic aspects of the sector: the intensive use of information in decision making and the limited access to, and consequently the insufficient use of, pertinent information that is potentially available (Kovacevic *et al.*, 2008). Studies have established that the lack of effective access to information is the primary cause of loss of productivity in the building design and construction process (Abanda *et al.*, 2022). As a result, party cooperation within a construction project may not work smoothly among all phases, including planning, procurement, etc. Party members may need to face consequences by poor management, which may be as serious as litigation (Cheung *et al.*, 2015; Hsu *et al.*, 2019; Mahfouz and Kandil, 2012; Wang *et al.*, 2021a and b). A need to facilitate management process and lower barriers among all contract parties is overwhelming.

Therefore, it is important and cost-effective to extract and understand text data automatically and intelligently. It is becoming increasingly clear that exploitation of Natural Language Processing (NLP) can fulfill the above purpose (Siebelink *et al.*, 2018; Abanda *et al.*, 2022; Corneli *et al.*, 2023). One of the most significant benefits of NLP assistant is the ability to understand and respond to natural language queries. The use of NLP can help the project manager and the client to express project requirements in alphanumerical and quantifiable terms avoiding misunderstanding and increasing the project's chances of success (Di Giuda *et al.*, 2020a). The use of NLP in the early stages of defining project requirements can be therefore considered a risk mitigation technique. This means that project participants can simply ask questions in natural language rather than having to navigate through the system using traditional means (such as clicking through menus or typing in keywords) and receive

accurate and relevant information without the necessity of deep knowledge of Industry Foundation Classes (IFC) or other standards (Dar *et al.*, 2019).

In the light of the above background, it is obvious that information flow management has historically been a problem in the construction industry. Fragmentation of processes within the sector, interdisciplinarity, and lack of unambiguous methods for passing information are some of the obstacles that make it difficult to have a non-splintered flow of data (Di Giuda *et al.*, 2020a). BIM approach is, if well adopted, a valuable support for optimal information flow management. Therefore, studies suggest that the use of NLP with vocal assistants can facilitate the access and understanding of the information to non-technical users (Siebelink *et al.*, 2018; Abanda *et al.*, 2022; Corneli *et al.*, 2023). This necessitated an assessment of influence of adoption of NLP on construction sites management in Abuja with a view to enhancing effective information management in construction projects. In order to achieve this aim, the study: examine the drivers and barriers to the effective adoption of NLP for effective construction site management; determined the effects of the adoption of NLP on construction site management capabilities in construction projects; and developed the strategies for enhancing the adoption of NLP for effective construction site management in Abuja.

Literature Review

This section undertook an extant review of existing literature in line with the themes of the aim and objectives of the study. this also made it possible for the data required for the fieldwork to be identified.

Drivers for Effective Adoption of NLP for Effective Construction Site Management

NLP is a set of techniques that aid machines in comprehending human languages by analyzing text structures and meanings (Wu *et al.*, 2020; Rampini and Cecconi, 2022). In the same vein, Leidner (2023) reported that it is notoriously difficult to construct conventional software systems systematically and timely, with up to 20% of industrial development projects failing. Even for NLP applications, the none of the existing studies seem to have estimated project failure rate. The risks of failure seem even higher in this area. However, the language engineer can address additional complexity due to these risk by embracing several drivers. These drivers are: Accuracy; Efficiency; Flexibility; Productivity; Robustness;

Scalability; Multimodality; and Multilinguality. In terms of accuracy, a fundamental difference between NLP systems and conventional software is the incompleteness property: since current language processing techniques can never guarantee to provide all and only the correct results, the whole system design is affected by having to take this into account and providing appropriate fallbacks. In terms of efficiency, human users are very demanding; Leidner (2023) reported that system response times in which scenarios natural language interaction with machines is superior to menus, keyboard commands or other means. In terms of flexibility, like any software, NLP systems need to be flexible: a parser developed primarily to analyze written online newspaper text might well be employed tomorrow to process business e-mails. Different data formats have to be handled, so representational and input/output knowledge needs to be factored out from core linguistic processing knowledge.

Barriers to Effective Adoption of NLP for Effective Construction Site Management

Artificial Intelligence (AI) is a fast-growing area of study that stretching its presence to many business and research domains. Machine learning, deep learning, and natural language processing (NLP) are subsets of AI to tackle different areas of data processing and modelling (Abioye *et al.*, 2021; Shaik *et al.*, 2022). In addition to this, Shaik *et al.* (2022) identified six (6) main barriers to effective adoption of NLP for effective construction site management. These barriers are: Domain-Specific Language; Sarcasm; Ambiguity; Emoticons and Special Characters; Aspect-Based Sentiment Analysis; and Data Imbalance. In order to classify academic dataset or students' feedback, it is required to understand core factors of teaching context. This is considered one of the challenges in implementing NLP in education domain. Considering abundant student feedback being generated from different surveys, questionnaires, and other educational feedback acquiring portals on a course teaching or a learning management system.

Effects of Adoption of NLP on Construction Site Management Capabilities in Construction Projects

NLP is a natural tool for the asset management industry because many activities of asset managers are driven by text data. Indeed, many of the alternative data trends require NLP capabilities to fully leverage their potential. It studies theories and method for realizing human-computer interaction based on natural language (Chowdhury, 2003). NLP applications in construction have mostly invested the following processes: document management (Wu *et al.*, 2020), safety management (Cheng *et al.*, 2020), compliance

checking (Xue and Zhang, 2020), risk management (Lee *et al.*, 2020) and BIM management (Xie *et al.*, 2019; Zhou *et al.*, 2020). As far as the latter is concerned NLP has been adopted to solve a well-known problem of AECO sector: information retrieval. Wu *et al.* (2019) presented a natural-language-based intelligent retrieval engine for the BIM object database and Revit modeling. They developed first and IFC-based BIM object database and then a search engine that speed up the process of retrieving building components for modelling. Therefore, the use of NLP can help the project manager and the client to express project requirements in alphanumerical and quantifiable terms avoiding misunderstanding and increasing the project's chances of success (Di Giuda *et al.*, 2020b). In addition, the use of NLP in the early stages of defining project requirements can be therefore considered a risk mitigation technique. ANN approach to NLP also allows to define requirements and predictions in order to monitor the progress of the project. This, in turn, leads to an optimization of the definition of requirements and the assessment of the project progress.

Strategies for Enhancing Adoption of NLP for Effective Construction Site Management

Studies have established that the use of NLP for the definition of initial requirements would have a greater impact if applied at an early stage (Di Giuda *et al.*, 2020b; Abioye *et al.*, 2021). The NLP approach could be used for the definition of the initial requirements of a public client helping the public actor to define requirements on a numerical and alphanumerical basis and not on a simple text basis. Through the alphanumeric requirements translation, the public client would be the main actor in a Data-driven construction process, increasing its ability to understand, manage and direct the outcome of the design (Xie *et al.*, 2019; Zhou *et al.*, 2020). The numerical translation of the requirements would make the entire process computable, and digitally manageable, which would see the client as able to contribute directly to the design process. NLP supports requirements engineering by transforming the classic qualitative demand based on text data into a computational demand based on formal and structured data. During a data-driven process, the monitoring of the objectives to be achieved can be more effective and immediate, reducing the risk of overcoming time and costs and not reaching the expected quality level.

Research Methodology

This study adopted the survey research design. In view of this, the quantitative research approach was adopted for this study. Therefore, the use of structured questionnaire was employed to collect data. The population for the study was made up of the 197 professionals

that are engaged in construction projects executed by Federal Capital Development Authority (FCDA) in Abuja. Based on three (3) major criteria set for qualifying professionals chosen for the study, 85 professionals made up the sample size for this study. Therefore, purposive sampling technique was used for selecting the professionals based on the awareness of respondents on NLP; active involvement in construction site on-site communication and management activities; and involvement in the decision-making of the organisation. In the course of the fieldwork, eighty-five (85) copies of questionnaires were distributed to construction professionals that are engaged in construction projects executed by FCDA in Abuja of which fifty (50) copies were retrieved and used for analysis. Therefore, the response rate was 58.82%. The analysis of data was undertaken with the use of Relative Importance Index (RII) and Spearman Rank correlation analysis. The decision rule to be adopted for the RII analysis are summarized in Table 1.

Table 1: Decision Rule for RII Analysis

Scale	Cut-Off Point		Interpretation			
	<i>RII</i>	<i>Level of Importance</i>	<i>Level of Severity</i>	<i>Level of Significance</i>	<i>Level of Effectiveness</i>	
5	0.81 -	Extremely	Extremely	Extremely	Extremely	
	1.00	Important	Severe	Significant	Effective	
4	0.61 -	Very Important	Very Severe	Very Significant	Very Effective	
	0.80					
3	0.41 -	Important	Severe	Significant	Effective	
	0.60					
2	0.21 -	Less Important	Less Severe	Less Significant	Less Effective	
	0.40					
1	0.00 -	Least Important	Least Severe	Least Significant	Least Effective	
	0.20					

Source: Adapted and Modified from Shittu *et al.* (2021) and Shittu *et al.* (2022)

For the Spearman Rank correlation, the decision rules for the nature of correlation state that if coefficient of correlation (r) = 0.10 to 0.29, then there is small amount of correlation; if r = 0.30 to 0.49, then there is medium amount of correlation; and if r = 0.50 - 1.0, then there is large amount of correlation between the variables, as opined by Pallant (2013).

Results and Discussion

This section presents the profile of respondents as well as the results of the analysis undertaken for the study.

Examination of Drivers for Effective Adoption of Natural Language Processing for Effective Construction site Management

It was revealed from the results of the RII analysis presented Table 2 that the most significant drivers for the effective adoption of NLP for effective construction site management are “Efficiency” (RII = 0.83) and “Accuracy” (0.82). The least significant driver for the effective adoption of NLP for effective construction site management is “Robustness” (RII = 0.70). On the average, all the drivers for the effective adoption of NLP for effective construction site management in Abuja are very significant (average RII = 0.95). Finding from past studies support the results of this research here by establishing that in terms of multilinguality, in a globalized world, users want to work with a system in multiple languages (Wu *et al.*, 2022; Rampini and Cecconi, 2022; Leidner, 2023).

Table 2: Drivers for the Effective Adoption of NLP for Effective Construction Site Management

Code	Drivers for the Effective Adoption of NLP	RII	Rank	Decision
No.	for Effective Construction Site Management			
C2	Efficiency	0.83	1st	Extremely Significant
C1	Accuracy	0.82	2nd	Extremely Significant
C11	Automated compliance checking, i.e., automatically comparing as-is situation (e.g.,	0.79	3rd	

working plans) with requirements (e.g., contracts and standards) and identifying non-compliance

C6	Productivity	0.78	4th	Very Significant
C8	Filtering information, i.e., extracting key information from noisy texts for specific purposes (e.g., finding accident causes from reports)	0.78	4th	Very Significant
C9	Organizing documents, i.e., automatically grouping documents of different backgrounds (e.g., drawings from different disciplines) and enabling timely retrieval	0.78	4th	Very Significant
C5	Multilinguality	0.77	7th	Very Significant
C10	Expert systems, i.e., integrating expert knowledge and providing answers for engineering problems	0.76	8th	Very Significant
C3	Scalability	0.75	9th	Very Significant
C4	Multimodality	0.74	10th	Very Significant
C7	Robustness	0.70	11th	Very Significant
Average RII		0.75		Very Significant

Examination of Barriers to Effective Adoption of Natural Language Processing for Effective Construction Site Management

It was shown from the results of the RII analysis presented in Table 3 that the most severe barriers to the effective adoption of NLP for effective construction site management are “Ambiguity” and “The manual conformity control process is time-consuming, costly, and

error-prone” (RII = 0.74 respectively). The least severe barrier to the effective adoption of NLP for effective construction site management is “Homophones” (RII = 0.61). On the average, all the barriers to the effective adoption of NLP for effective construction site management in Abuja are very severe (average RII = 0.68). Past studies agree with the findings of this research in this area by reporting that construction workers often have to communicate with software applications e.g., BIM on the construction site, but typing on devices to retrieve information could lead to safety hazards (Abioye *et al.*, 2021).

Table 3: Barriers to Effective Adoption of NLP for Effective Construction Site Management

Code	Barriers to the Effective Adoption of NLP	RII	Rank	Decision
No.	for Effective Construction Site Management			
D1	Ambiguity	0.74	1st	Very Severe
D2	The manual conformity control process is time-consuming, costly, and error-prone	0.74	1st	Very Severe
D6	Lack of data inherent in natural language	0.73	3rd	Very Severe
D4	Usually very noisy, which puts unwanted information in the speech signal	0.71	4th	Very Severe
D17	Information flow management has historically been a problem in the construction industry	0.71	5th	Very Severe
D3	Safety hazards	0.70	6th	Very Severe
D9	Voice enhancement	0.69	7th	Very Severe
D14	Emoticons and Special Characters	0.69	7th	Very Severe
D8	Speaker variability	0.69	7th	Very Severe
D15	Aspect-Based Sentiment Analysis	0.69	7th	Very Severe
D7	Errors which may frustrate the users and eventually lead to discontinuity of use	0.68	11th	Very Severe
D11	Amount of data and search space	0.68	11th	Very Severe

D18	Fragmentation of processes within the construction sector	0.67	13th	Very Severe
D16	Data Imbalance	0.67	13th	Very Severe
D19	Interdisciplinarity	0.66	15th	Very Severe
D12	Domain-Specific Language	0.64	16th	Very Severe
D5	Imprecision	0.64	16th	Very Severe
D13	Sarcasm	0.63	18th	Very Severe
D10	Homophones	0.61	19th	Very Severe
<i>Average RII</i>		<i>0.68</i>		<i>Very Severe</i>

Determination of Effects of Adoption of Natural Language Processing on Construction Site Management Capabilities in Construction Projects

The effect of adoption of NLP on construction site management capabilities in construction projects was determined with the use of RII and Spearman Rank correlation analysis. The use of RII was adopted to rank the perception of respondents on the perceived effects of adoption of NLP on construction site management capabilities in construction projects. On the other hand, Spearman Rank correlation analysis was used to inferentially determine the relationship between the benefits of adoption of NLP and the strategies for enhancing the adoption of NLP for effective construction site management.

Perceived effects of the adoption of NLP on construction site management capabilities in construction projects

The results of the RII analysis used to rank the perception of respondents on the perceived effects of the adoption of NLP on construction site management capabilities in construction projects are summarised in Table 4. It was revealed that the most significant effect of the adoption of NLP on construction site management capabilities in construction projects is “NLP is of significant benefits in the areas of Information management; Procurement management; Risk management; Requirement management; Automated compliance checking; Construction management; and Construction safety” (RII = 0.84). The least significant effects of the adoption of NLP on construction site management capabilities in

construction projects are “Time efficiency” and “Reduced mistakes and omissions” (RII = 0.70 respectively). On the average, all the perceived effects of the adoption of NLP on construction site management capabilities in construction projects are very significant (average RII = 0.73).

Table 4: Effects of the Adoption of NLP on Construction Site Management Capabilities in Construction Projects

Code	Effects of the Adoption of NLP on	RII	Rank	Decision
No.	Construction Site Management Capabilities in Construction Projects			
E1	NLP is of significant benefits in the areas of Information management; Procurement management; Risk management; Requirement management; Automated compliance checking; Construction management; and Construction safety	0.84	1st	Extremely Significant
E2	The use of NLP can help the project manager and the client to express project requirements in alphanumeric and quantifiable terms avoiding misunderstanding and increasing the project's chances of success	0.76	2nd	Very Significant
E7	Simplified monitoring and control	0.76	2nd	Very Significant
E9	Ability to explain reasoning behind solution	0.76	2nd	Very Significant
E12	Improved safety	0.76	2nd	Very Significant
E4	Increased productivity	0.76	2nd	Very Significant
E3	It leads to an optimization of the definition of	0.75	7th	Very Significant

requirements and the assessment of the project
progress

E6	Cost effectiveness	0.74	8th	Very Significant
E8	Easy access to relevant information	0.73	9th	Very Significant
E10	Clear logic	0.73	9th	Very Significant
E14	Improves communication among stakeholders	0.73	9th	Very Significant
E5	Consistency and availability	0.72	12th	Very Significant
E11	Time efficiency	0.70	13th	Very Significant
E13	Reduced mistakes and omissions	0.70	13th	Very Significant
<i>Average RII</i>		<i>0.73</i>		<i>Very Significant</i>

Relationship between adoption of NLP and strategies for enhancing the adoption of NLP for effective construction site management

Before carrying out Spearman Rank correlation analysis, the reliability and suitability of the data for Spearman rank Correlation analysis was first tested. In view of this, the reliability test carried out between the benefits of adoption of NLP and strategies for the adoption of NLP for effective construction site management in Abuja shows no evidence of outliers with a scatterplot with the data points spread all over the place, suggesting a very high correlation. This shows that the data set is fit for Spearman Rank correlation analysis. Figure 4.3 shows the graph of the scree plot of the relationship between the benefits of adoption of NLP and strategies for the adoption of NLP for effective construction site management.

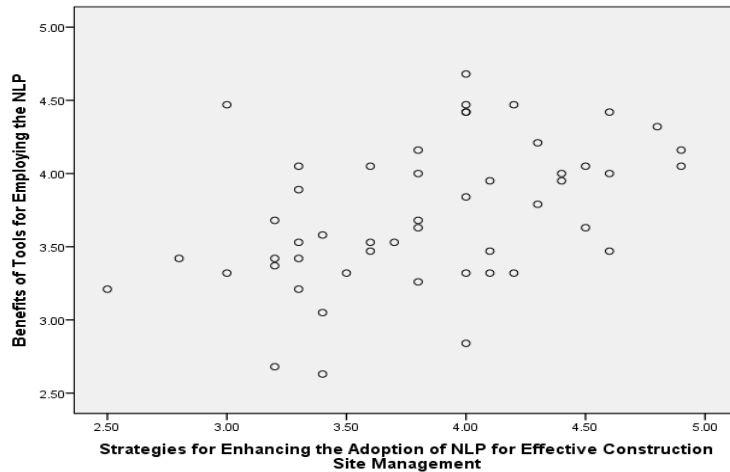


Figure 1: Scree Plot between Benefits of Adoption of NLP and Strategies for Adoption of NLP for Effective Construction Site Management

After confirming the reliability and suitability of the data for Spearman Rank correlation analysis, the relationship between the benefits of adoption of NLP and strategies for the adoption of NLP for effective construction site management was determined. The Spearman rank correlation analysis results revealed that there exists a slightly strong, positive and significant relationship between the benefits of adoption of NLP and effects of adoption of NLP for effective construction site management in Abuja. The positive correlation indicates that improvement in the level of implementation of the strategies for adoption of NLP will result in the increase in the level of adoption of NLP for effective construction site management in Abuja. The correlation coefficient (r value) observed was 0.452 indicating slightly strong degree of association between the variables. Hence, the correlation between the variables is medium (Pallant, 2013). The probability (P_{value}) value of 0.001 observed was less than the level of significance adopted for the study (0.01). This implies a significant relationship between the variables. Therefore, the effect of effects of the adoption of NLP on construction site management capabilities in construction projects in Abuja is very significant. The results of the Spearman Rank correlation analysis are summarised in Table 5. In line with the findings of this study, findings from past studies also found a significant relationship between the adoption of NLP and construction site management capabilities in construction projects. This is because studies have discovered that the use of NLP can help the project manager and the client to express project requirements in alphanumeric and

quantifiable terms avoiding misunderstanding and increasing the project's chances of success (Abioye *et al.*, 2021; Di Giuda *et al.*, 2020a).

Table 5: Relationship between Benefits of Adoption of NLP and Strategies for Adoption of NLP for Effective Construction Site Management

VARIABLES		OBSERVATIONS		INFERENCES		
X ₁	X ₂	<i>r</i> (%)	LOS	P _{value}	Strength of Relationship	Remark
Benefits of Adoption of NLP	Strategies for Effective Adoption of NLP	0.452	0.01	0.001	Slightly Strong	SS

KEY:

SS	=	Statistically Significant
<i>r</i>	=	Correlation Coefficient
LOS	=	Study's Level of Significance
P _{value}	=	Calculated Probability Value

Development of Strategies for Enhancing Adoption of NLP for Effective Construction Site Management

It was revealed from the results of the RII analysis presented in Table 6 that the most effective strategy for enhancing adoption of NLP for effective construction site management is "Allowing potential non-compliance cases to be identified in advance, which could save significant time and cost due to changes and/or rework" (RII = 0.80). The least effective strategy for enhancing adoption of NLP for effective construction site management is "Promoting the adoption of Building Information Modelling (BIM) and increase the cumulative benefits of adopting BIM as BIM would allow ACC" (RII = 0.72). On the average, all the strategies for enhancing adoption of NLP for effective construction site management in Abuja are very effective (average RII = 0.75). In line with the findings of this

study, past studies have also established that the strategies for enhancing the adoption of NLP in construction projects are effective. This is because it was indicated by past studies that to adjust a pretrained model for specific problems and domains, researchers fine-tune their models by further training them on the desired domain and making small adjustments to the underlying model to achieve the desired output or performance(Xie *et al.*, 2019; Zhou *et al.*, 2020; Di Giuda *et al.*, 2020a).

Table 6: Strategies for Enhancing the Adoption of NLP for Effective Construction Site Management

Code	Strategies for Enhancing the Adoption of	RII	Rank	Decision
No.	NLP for Effective Construction Site Management			
F6	Allowing potential non-compliance cases to be identified in advance, which could save significant time and cost due to changes and/or rework	0.80	1st	Very Effective
F1	Development of a robust dataset of common voice commands in different situations on the construction site should be collected	0.78	2nd	Very Effective
F9	Experimenting different design options and checking for compliance would be more efficient in terms of time	0.78	3rd	Very Effective
F4	Training and re-training of personnel on the desired domain and making small adjustments to the underlying model to achieve the desired output or performance	0.77	4th	Very Effective

F5	NLP approach can reduce time and cost in defining requirements by avoiding errors, loss of information and ambiguities in defining project objectives	0.77	5th	Very Effective
F8	Enabling more efficient integration of stakeholder inputs into the design and exploration of what-if design scenarios	0.77	6th	Very Effective
F10	Reducing violations of regulations, due to easier and more frequent Compliance Checking	0.77	7th	Very Effective
F2	The use of NLP with vocal assistants can facilitate the access and understanding of the information to non-technical users	0.76	8th	Very Effective
F3	Adoption of BIM approach as a valuable support for optimal information flow management	0.74	9th	Very Effective
F7	Promoting the adoption of Building Information Modelling (BIM) and increase the cumulative benefits of adopting BIM as BIM would allow ACC	0.72	10th	Very Effective
<i>Average RII</i>		<i>0.75</i>	<i>Very Effective</i>	

Conclusion and Recommendations

The most significant drivers for the effective adoption of NLP for effective construction site management were found to be “Efficiency” and “Accuracy”. The study also revealed that most severe barriers to the effective adoption of NLP for effective construction site management are “Ambiguity” and “The manual conformity control process is time-

consuming, costly, and error-prone”. The study also found that there is a significant effect between the adoption of NLP and construction site management capabilities in construction projects. Finally, the study revealed that most effective strategy for enhancing adoption of NLP for effective construction site management is “Allowing potential non-compliance cases to be identified in advance, which could save significant time and cost due to changes and/or rework”. The study therefore concludes that the influence of the adoption of NLP on construction sites management in Abuja is very significant and capable of enhancing effective information management in construction projects provided some basic strategies are implemented.

In view of the findings and conclusion, the study recommends that the management of construction firms should place more priority on efficiency and accuracy in the transfer of information on site so as to enhance the adoption of NLP for effective information management in construction projects. In the transmission of information in construction projects, employees should avoid ambiguity and time-consuming, costly, and error-prone manual conformity control process in order to prevent the adoption of NLP for effective information management in construction projects from being inefficient. The management of construction firms should develop a mechanism for enhancing the adoption of NLP for effective information management in construction projects by using the strategies developed in this study as a basis.

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**PRODUCT INNOVATION STRATEGIES OF DEPOSIT MONEY BANKS – A
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rafat1650@futminna.edu.ng, memoade4real@yahoo.com, maijaiya@futminna.edu.ng
[08065238773](tel:08065238773)**ABSTRACT**

The 21st century is an era of technological advancement and evolving customer preferences, where deposit money banks (DMBs) are faced with the imperative to continually innovate their product offerings to remain competitive and contribute significantly to socio-economic growth and national development. Therefore, this study examines the pivotal role of product innovation strategies deployed by DMBs in fostering sustainable socio-economic growth and facilitating national development. The study adopts desk-review methods, drawing upon comprehensive review of extant literatures to achieve its objective. This paper is segmented whereby the concept of product innovation strategies and its significance in the banking sector is discussed. Dimensions of product innovation strategies adopted by deposit money banks are highlighted and explained; symbiotic relationship between product innovation strategies of deposit money banks and sustainable socio-economic growth and national development discussed; and the challenges faced by deposit money banks in meeting the evolving customers' needs were stated. In conclusion, the review reveals that DMBs' product innovation strategies encompass a wide array of initiatives, ranging from digital banking solutions to customized financial products tailored to meet diverse customer needs and remain sustainable.

Keywords: Product Innovation Strategies, Deposit Money Banks, Socio-economic Growth, National Development, Financial Inclusion.

1.0 Introduction

In this dynamic landscape of modern finance, Deposit money banks (DMBs) play a pivotal role in driving economic progress and national development (Arogundade and Adegbe, 2024). As key financial intermediaries, they facilitate the flow of funds from savers to borrowers, thereby fostering economic activities that spur growth and prosperity (Oluranti et al., 2024). However, in this era marked by rapid technological advancements, globalization, and shift in customers preferences, traditional banking models face unprecedented challenges (Basdekiset al., 2022). To navigate this evolving terrain and unlock new avenues for sustainable socio-economic growth, DMBs are increasingly turning to product innovation strategies, offering not only a competitive edge but also serving as a potent driver for sustainable socio-economic growth and national advancement (Matherly et al., 2021).

The unprecedented disruptions witnessed by banking sector, characterized by the emergence of fintech startups, shifting regulatory landscapes, and evolving customer preferences, compelled DMBs to reevaluate their strategies (Akinbode *et al.*, 2023). The traditional banking models, once synonymous with stability and reliability, now confront the imperative of adaptability and innovation. It is at the heart of this transformation lies the concept of product innovation, which is a strategic approach that entails the development and deployment of novel financial products, services, and delivery channels tailored to meet the evolving needs of customers and stakeholders (Agyei-Boapeah *et al.*, 2022).

Hence, this study reviewed product innovation strategies of deposit money banks: a panacea for sustainable socio-economic growth and national development.

1.1 Objective of the study

The main objective of this study is to assert the concept of product innovation strategies of deposit money banks as a panacea for sustainable socio-economic growth and national development. To explore how innovation in the banking products and services can contribute to broader socio-economic development goals at the national level.

1.2 Justification of the study

Innovative banking products can address the financial needs of the different segments of society, including small and medium-sized enterprises (SMEs), farmers, and low-income citizens. This can lead to improved standard of living, reduced poverty, and enhanced social welfare. Sustainable socio-economic growth requires not only short-term gains but also long-term viability. By focusing on innovation, deposit money banks can develop products and services that meet the evolving needs of customers while also ensuring the sustainability of their operations and the broader economy.

1.3 Significance of the study

The significance of product innovation strategies adopted by deposit money banks goes beyond the realm of corporate competitiveness, transcending into broader socio-economic implications (Babu *et al.*, 2022). By fostering financial inclusion, empowering small and medium enterprises (SMEs), and catalyzing entrepreneurship, innovative banking solutions serve as potent instruments for poverty alleviation, job creation, and wealth distribution (Falaiye *et al.*, 2024). Moreover, by channeling resources towards productive sectors of the

economy, DMBs can stimulate investment, spur innovation, and fuel economic expansion, thereby contributing to overall national development objectives (Babarinde *et al.*, 2022).

2.0 Dimensions of product innovation strategies

Product innovation strategies employed by deposit money banks (DMBs) encompass various dimensions aimed at enhancing customer satisfaction, expanding market reach, and staying competitive. Some of these dimensions includes; *Technology Integration and Digitalization* - this involves developing digital banking platforms, mobile apps, and online services to provide customers with convenient and efficient banking experiences (De Venn, 2023). With the rise of fintech and changing customer preferences, DMBs are leveraging technology to streamline processes, reduce costs, and offer innovative services such as mobile banking, contactless payments, and AI-driven chatbots for customer support (Lottuet *et al.*, 2023). The second dimension is *Customization and Personalization* - DMBs tailor their products to meet the specific needs and preferences of different customer segments (Grassiet *et al.*, 2022). This could involve personalized banking packages, targeted promotions, and customized financial solutions. By understanding customers' unique requirements, DMBs can create tailored products and services that resonate with individual preferences, leading to higher customer satisfaction and loyalty. The third dimension is *Product Diversification* – in this case, DMBs expand their product portfolios beyond traditional banking services (Akwam and Yua, 2021). This includes introducing investment products, insurance offerings, and value-added services such as wealth management and advisory services. Product diversification allows DMBs to cater to a broader range of financial needs, attract new customers, and generate additional revenue streams, thereby strengthening their competitive position in the market (Agyei-Boapeahet *et al.*, 2022).

Another dimension of product innovation strategy is *Collaboration and Partnerships* – where DMBs can forge strategic partnerships with fintech firms, technology providers, and other organizations to enhance their product offerings and tap into new markets (Kelly *et al.*, 2017). This collaboration may involve co-branded products, joint ventures, or API integrations. Partnering with external entities enables DMBs to leverage complementary expertise, access innovative technologies, and reach underserved customer segments more effectively, fostering mutual growth and innovation (Iheanachor and Umukoro, 2022). The fifth dimension is *Regulatory Compliance and Risk Management* – here, DMBs carry out innovation within the regulatory framework to ensure compliance with evolving industry

regulations and mitigate associated risks (Hassan *et al.*, 2023). This includes adopting robust risk management practices, implementing compliance solutions, and staying abreast of regulatory changes. Moreover, adhering to regulatory requirements is essential for maintaining trust and credibility in the banking sector (Gbenga *et al.*, 2024). Owing to this, imbuing innovation in risk management and regulatory compliance, will ensure operational resilience, safeguard customer data, and uphold regulatory standards while pursuing innovation in their product offerings.

The last dimension covered by this study, is *Customer Experience Enhancement* – where DMBs focuses on enhancing the overall customer experience by simplifying processes, improving accessibility, and providing proactive support. This may involve investing in user-friendly interfaces, optimizing service delivery channels, and incorporating customer feedback mechanisms. A seamless and enjoyable customer experience is paramount for retaining existing customers and attracting new ones (Susian *et al.*, 2023). By innovating in customer experience, DMBs can differentiate themselves from competitors, foster loyalty, and drive long-term growth.

In summary, deposit money banks employ various dimensions of product innovation strategies to adapt to changing market dynamics, meet customer needs, and maintain a competitive edge in the financial services industry (Mang'ana, 2022). These strategies encompass technological advancements, customization, diversification, collaboration, regulatory compliance, risk management, and customer experience enhancement (Hassan *et al.*, 2023). By embracing innovation across these dimensions, DMBs can drive sustainable growth and deliver greater value to their customers.

3.0 Deposit money banks and sustainable socio-economic growth and national development

Deposit money banks, also known as commercial banks, play a crucial role in fostering sustainable socio-economic growth and national development in several ways. Deposit money banks act as intermediaries between savers and borrowers, channeling funds from surplus units (depositors) to deficit units (borrowers) (Efanga *et al.*, 2022; Fatai and Alenoghena, 2024). By efficiently allocating capital, they facilitate investment in productive activities, leading to economic growth.

They provide credit to individuals, businesses, and governments, enabling them to invest in projects that contribute to socio-economic development (Ishioro, 2022). This includes

financing small and medium-sized enterprises (SMEs), infrastructure projects, and innovative ventures. Banks play a vital role in promoting financial inclusion by offering a range of financial products and services to previously underserved populations. Access to banking services such as savings accounts, credit facilities, and insurance can empower individuals and communities, lifting them out of poverty and fostering economic development. Deposit money banks facilitate efficient payments and transactions through various channels such as checks, electronic transfers, and mobile banking. By providing a reliable payment infrastructure, they contribute to the smooth functioning of the economy, promoting trade, and commerce.

Deposit money banks mobilize savings from individuals and institutions, which are then channeled into investments. This process contributes to capital formation, which is essential for sustained economic growth and development. They also play a crucial role in managing financial risks by diversifying their loan portfolios, conducting thorough credit assessments, and implementing risk management practices (Ben-Lahouet *et al.*, 2022). This ensures the stability of the financial system and promotes confidence among investors and depositors. Deposit money banks often collaborate with governments to implement economic policies aimed at promoting development objectives (Akeem *et al.*, 2022). This includes providing financing for priority sectors such as agriculture, education, healthcare, and renewable energy. Banks continually innovate and adopt new technologies to enhance their efficiency and expand their reach. Digital banking solutions, fintech partnerships, and innovative financial products contribute to greater financial inclusion and economic development. Many deposit money banks engage in CSR initiatives aimed at addressing social and environmental challenges (Tuyonet *et al.*, 2023). By investing in community development projects, environmental conservation, and sustainable business practices, banks contribute to the overall well-being of society. Banks provide critical financial support and advisory services to entrepreneurs and startups, fostering innovation, job creation, and economic diversification (Lottuet *et al.*, 2023).

These multifaceted roles of deposit money banks in promoting sustainable socio-economic growth and national development by mobilizing savings, providing credit, facilitating financial inclusion, managing risks, supporting government policies, fostering innovation, and contributing to social and environmental initiatives cannot overemphasized. Their

efficient functioning is essential for building resilient and inclusive economies (Vo *et al.*, 2021).

4.0 Challenges of product innovation strategies of deposit money banks

The pursuit of product innovation strategies of deposit money banks is not devoid of challenges. DMBs must navigate a complex landscape fraught with regulatory constraints, cybersecurity risks, and legacy infrastructure limitations. Moreover, the imperative of striking a delicate balance between innovation and risk management underscores the need for robust governance frameworks and strategic foresight. Nevertheless, by embracing a culture of innovation strategies, fostering collaboration with external partners, and adopting agile methodologies, deposit money banks can effectively navigate these challenges while harnessing the transformative potential of product innovation strategies (Akpa *et al.*, 2022).

As technology continues to evolve, customers increasingly expect seamless, convenient, and innovative banking solutions. Banks must invest in and adapt to emerging technologies such as mobile banking, digital wallets, and AI-driven customer service to meet these expectations. Deposit money banks are subject to strict regulatory requirements aimed at ensuring financial stability, consumer protection, and preventing money laundering and fraud (Frolova and Ermakova, 2022). Compliance with these regulations often requires significant resources and can limit banks' flexibility in meeting customer needs. With the growing prevalence of online banking and digital transactions, deposit money banks face increased cybersecurity risks. They must continuously invest in robust cybersecurity measures to protect customer data and prevent unauthorized access to accounts (Akintoye *et al.*, 2022).

Moreover, customer preferences and behaviors are constantly evolving, driven by factors such as demographics, socioeconomic trends, and cultural shifts. Banks must stay attuned to these changes and tailor their products and services accordingly to remain competitive. Deposit money banks also face competition not only from other banks but also from non-traditional financial players such as fintech startups, peer-to-peer lending platforms, and big tech companies entering the financial services sector. These new entrants often offer innovative solutions that challenge traditional banking models. In a low-interest-rate environment, deposit money banks may struggle to generate sufficient returns on their assets, which can impact their profitability and ability to invest in customer-centric initiatives. Many deposit money banks operate on legacy systems and processes that were designed for a different era (Stulz, 2022). These outdated systems can hinder agility and innovation, making it difficult to

meet the evolving needs of customers in a rapidly changing market. Despite efforts to improve financial inclusion, there are still significant segments of the population, particularly in developing countries, that remain underserved by traditional banking services. Deposit money banks face the challenge of reaching these underserved populations while ensuring affordability and accessibility of their services.

Addressing these challenges requires deposit money banks to be proactive in adopting new technologies, fostering a customer-centric culture, and embracing innovation while also maintaining compliance with regulatory requirements and managing risks effectively.

5.0 Symbiotic relationship between product innovation strategies of deposit money banks and sustainable socio-economic growth and national development

The symbiotic relationship between product innovation strategies of deposit money banks (DMBs) and sustainable socio-economic growth, as well as national development, is multifaceted and crucial for fostering economic progress (Stashchuk *et al.*, 2023).

Innovative banking products, such as mobile banking, digital wallets, and microfinance solutions, can enhance financial inclusion by reaching previously underserved populations (Tayet *et al.*, 2022). This expanded access to financial services empowers individuals and businesses to participate more actively in economic activities, leading to increased productivity and economic growth. DMBs can develop tailored financial products and services to meet the unique needs of small and medium-sized enterprises (SMEs) and entrepreneurs. By providing access to credit, investment capital, and financial advisory services, banks can stimulate entrepreneurship, job creation, and innovation, which are essential drivers of economic development. DMBs play a pivotal role in financing sustainable development initiatives, such as renewable energy projects, green infrastructure, and environmentally friendly technologies (Zhanget *et al.*, 2022).

By incorporating environmental, social, and governance (ESG) criteria into their lending and investment decisions, banks can contribute to sustainable socio-economic growth while mitigating environmental risks. Embracing technological advancements and digital innovation allows DMBs to enhance operational efficiency, reduce costs, and improve customer experiences. By investing in fintech solutions, artificial intelligence, blockchain technology, and data analytics, banks can streamline processes, offer innovative financial products, and adapt to changing consumer preferences, thereby driving economic progress (Chahal,

2023). DMBs can support socio-economic development by promoting financial literacy and education initiatives. By empowering individuals with the knowledge and skills to make informed financial decisions, banks can enhance financial resilience, promote savings culture, and facilitate wealth accumulation, which are vital components of sustainable development.

Collaboration between DMBs, government agencies, non-profit organizations, and other stakeholders is essential for driving inclusive growth and national development. By forming strategic partnerships, banks can leverage collective expertise, resources, and networks to address complex socio-economic challenges, such as poverty alleviation, infrastructure development, and inclusive growth agendas.

The symbiotic relationship between product innovation strategies of DMBs and sustainable socio-economic growth, and national development, is characterized by the banks' ability to drive financial inclusion, support entrepreneurship and SMEs, finance sustainable projects, embrace technology and digital transformation, promote financial literacy, and foster collaboration with diverse stakeholders (Stashchuket *al.*, 2023). By harnessing the power of innovation and responsible banking practices, DMBs can catalyze economic progress while advancing social and environmental objectives for the benefit of society as a whole.

6.0 Theoretical Framework

This study is based on Schumpeter's theory of economic development (1911), where the founder Joseph A. Schumpeter outlined in his seminal work "The Theory of Economic Development," that focuses on the dynamics of innovation and entrepreneurship. Innovation is one of the five main elements of this theory. Schumpeter emphasized the central role of innovation in driving economic growth and development (Sagaret *al.*, 2023). He defined innovation broadly to include the introduction of new products, processes, technologies, business models, and organizational methods.

7.0 Methodology

The desk review method is used to position the extant literature. It provides a quick and trustworthy background information, which enhances the focus of other primary researches by providing context and depth of research findings.

8.0 Conclusion

Conclusively, the advent of product innovation heralds a new era of possibilities for deposit money banks, presenting both challenges and opportunities in equal measure. By embracing a strategic approach to innovation, DMBs can not only enhance their competitive positioning but also serve as catalysts for sustainable socio-economic growth and national development. As the banking landscape continues to evolve, the imperative of product innovation strategies remains indispensable, offering a pathway towards a more inclusive, resilient, and prosperous future for economies and societies worldwide.

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INNOVATIVE TECHNOLOGY AND DATA PROTECTION PRACTICE OF FEMALE TECHNOLOGY ENTREPRENEURSHIP IN SOUTH-WEST NIGERIA

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ABSTRACT:

FemTech is a rapidly developing sector that focuses on taking advantage of technology to address women's health and well-being. It has witnessed a growth of entrepreneurial activities in Nigeria, especially in the South-west region. Hence, this paper explores the dynamic intersection of innovative technologies and data protective practices within the growing field of FemTech entrepreneurship in South-west Nigeria. The methodology employed for the study is a desk review of relevant literature on current FemTech initiatives. The study discusses how entrepreneurs in Nigeria are utilizing innovative technologies, such as mobile applications, wearables, and telehealth solutions to create meaningful solutions for women's health. In addition, the data protective measures used by FemTech entrepreneurs to navigate regulatory environment, secure sensitive health data, and cultivate user trust. Under the umbrella of data protection, several components are essential, ensuring data security, data privacy and integrity of data. This papers suggests that FemTech entrepreneurs should engage regulatory bodies to shape the core of data protection that ensures user privacy is key, consumers' data should be used responsibly, investment in cyber security measures, regular security audits, encryption technologies, secure data storage practices that would guard against the risks associated with data breeches and unauthorized access. It further suggests that an empirical study on this conceptual paper be explored.

Keywords: Innovative technology, Femtechs, Data security, Data privacy, Data Intergrity.

Introduction

The field of technology entrepreneurship has experienced significant growth and diversification in the last few decades, as breakthrough in information technology and universal availability of digital tools and the changing global landscapes have created the opportunity for innovative startups. Among these innovative startups are female led technology firms, also referred to as FemTechs startups, they have emerged and gained importance for their contributions to technological innovation and empowerment of women. Despite its popularity, Femtech remains a significantly underdeveloped area of health tech. A mere 4% of all healthcare research and development is targeted specifically at Women's health, even though women spend an estimated \$500 billion annually in medical expenses (Ravid and Tobey, 2020).

The last decade, has seen a rise in businesses leveraging technology to offer products and services dedicated to improving women's health. This new market segment has been dubbed FemTech (Menking and Kaplan, 2020). The FemTech sector is forecast to represent a \$1.186

trillion market by 2027, illustrating its vast potential (Alexandre, 2023). According to Folkendt (2019) FemTech refers to software, diagnostics, products and services that use technology to support women's health. The term itself was originally coined by Ida Tin, the founder of Clue, a period tracking app. This sector is primarily concerned with addressing the whole lived experience of women. Innovations in this category usually fall into the following categories: Period care products, fertility & birth control, menopause, pregnancy & post pregnancy, breastfeeding and general healthcare.

The startup landscape in Africa has flourished massively in recent years. With a young and rapidly growing population, combined with advances in technology and mobile connectivity, the continent has become an attractive destination for entrepreneurs and investors alike (World Business Outlook, 2023). According to Ugwuode (2020), in Africa, the FemTech sector is very much in its infant stages but the potentials are immense for a number of reasons, cultural perceptions and stigma around the topics like infertility, reproductive and sexual health or menstruation mean that digital tools can be privately used like period tracking or fertility and contraception apps.

The Nigerian tech startup ecosystem is home to renowned tech entrepreneurs. These visionaries have created world-class products and services. Many of these innovations and discoveries have changed the space forever (Techeconomy, 2022). This study wishes to explore how users' data is protected within the rapidly growing innovative activities in the FemTech industry.

Recent studies have identified a number of privacy and security concerns related to the collection and use of personal and health data including the potential for unauthorized access, sharing, or misuse of this data, the need for strong data privacy protection practices (Alfawzan and Christen, 2023; Alfawzan et al, 2022; Mehrnezhad and Almeida, 2021). Despite the increasing adoption of technology driven solutions for women's health, there is a lack of comprehensive research on the effectiveness of data protection practices employed by Femtech startups in Southwest, Nigeria. This gap in understanding poses significant risks to user privacy and trust, as well as regulatory compliance, emphasizing the need for a focused examination of Femtech data protection practices to address emerging challenges and ensure secure and ethical handling of personal health data.

Methodology

This study used a desk review methodology of relevant literature on current FemTech initiatives to collect, evaluate and integrate relevant academic works and information on FemTech entrepreneurship in South-west Nigeria. A thorough search of academic databases, publications and industry reports was conducted to gather relevant literature. Key points were identified providing an understanding of how ensuring data security, data privacy and data integrity by FemTechs can contribute valuable understanding into the landscape of innovative technology and data protection practices of FemTechentrepreneurs' in South-west Nigeria.

FemTech Entrepreneurship in Nigeria

FemTech has the potential to radically improve women's lives everywhere and has already begun doing so with artificial intelligence (AI) improving healthcare outcomes and personalized medicine, FemTech stands to greatly benefit from this new technology. FemTech and AI joining forces will positively impact women's health and promote the need for more women to be represented in data sets (Kenneth, 2022). The Nigerian female entrepreneurs are increasingly bridging the gap in the country's healthcare system through investment and innovation. This highlights the transformative impact of technology on healthcare, specifically focusing on the intersection of innovation and women's health (Obokoh, 2019). According to Akindare (2021), over the last decade Nigeria's technology and innovation ecosystem has really entrepreneurs have created many impressive solutions and successful businesses to the country's problems by leveraging technology.

Data Protection Practice of Femtechs in Southwest Nigeria

Data protection is the set of systems and processes that guard an organization's data against loss, leak, theft and unavailability. A robust data protection practice monitors all data by sifting through trusted data movements to detect risky behaviors, allowing security teams to use their time efficiently. Data protection is essential as it helps companies prevent data breaches, infiltration, downtime and damage to reputation and finances. Organizations must also enforce data protection to restore lost or corrupted data and meet regulatory requirement (Miller, 2022).

Data protection is very important for FemTech startups in Southwest, Nigeria. This is because they handle sensitive health data that requires rigorous privacy precautions. Nigeria's health data regulatory landscape has been evolving over the last few years. In 2023, the Nigerian Data Protection Commission (NDPC) was established following the Nigeria Data

Protection Act. Empowering NDPC in implementing the Nigerian Data Protection Regulation (NDPR), this builds on the National Health Act of 2014 that ensures data security and privacy. Compliance with the data protection regulation of the NDPR, is essential to protect user privacy and build trust. FemTechs must implement robust data privacy frameworks, secure data storage and integrity and obtain user consent transparently (Aniegbe, 2024). Under the umbrella of data protection, several components are important, such as data security, data privacy and integrity of data. By integrating these components into their data protection strategy, organizations can mitigate guard against the risk of breaches, secure sensitive information, and maintain customers' trust.

Data Security in Femtech Entrepreneurship

Data security is a practice that involves the protection of digital information from unauthorized access, corruption, destruction, modification, theft or disclosure. The data security process encompasses techniques and technologies such as security of physical hardware, logical security of software applications, administrative and access controls, organizational policy standards, and other data security practices (Taylor, 2024). BasuMallick (2022) also defined data security as the technical process of protecting any computer system's information from unauthorized access or destruction. This encompasses any type of device, server or network of computer devices.

Data Security is an essential concern for FemTech entrepreneurs, this is because of the sensitive information collected and processed by the FemTech platforms. Security of electronic health record is an essential thread in healthcare fabric. Security entails the protection of online facilities housing health records. A security breach in the Femtech sector exposes providers to innumerable risk that can cause disruption of services, economic loss, reputational damage, reduced patient's confidence, and penalty under regulation (Oloyede, 2018).

According to (Nass et al, 2009) protecting the security of data in health research is important because health research requires the collection, storage, and use of large amounts of personally identifiable health information, much of which may be sensitive and potentially embarrassing. According to Deloitte's 2018 annual report, there is 525 percent increase in medical device cyber security vulnerabilities reported by the government.

Data Privacy considerations for Femtechs

Data privacy refers to the handling of critical personal information, also called personal identifiable information or personal health information. This information can include social security numbers, health records, and financial data, including bank account and credit card numbers (Tobin, 2024). According to (Kosinski and Forrest, 2023) data privacy also called information privacy is the principle that a person should have control over their personal data, including the ability to decide how organizations collect, store and use their data.

Privacy in the FemTech context refers to the customer's right to have control and keep his or her health information private. It also entails the circumstances in which a customer's protected health information may be used or disclosed. Right to privacy is a fundamental human right recognized by the Nigerian constitution. Beyond the constitutional provision and professional obligation, privacy adds another layer of legal obligation and protection (Oloyede, 2018).

Ensuring Data Integrity in Femtech Entrepreneurship

Data integrity is the assurance that digital information is uncorrupted and can only be accessed or modified by those authorized to do so. Data integrity describes data that's kept complete, accurate, consistent and safe throughout its entire lifecycle. The idea of data integrity is a central element of many regulatory compliance frameworks, such as the General Data Protection Regulation (GDPR) (Bigelow, 2024). According to Brook (2023), data integrity refers to the accuracy and consistency of data over its lifecycle. Compromised data, after all, is of little use to enterprises, not to mention the dangers presented by sensitive data loss.

Data integrity is very important for FemTechs in Southwest, Nigeria to deliver accurate and reliable health information to users. According to Hassan et al (2023) some Femtech apps do not adhere to the principles of data minimization, quality and integrity, these apps privacy policies claimed to collect more personally identifiable information (PII), such as user information and device identifiers, than was necessary for their core functionality. Furthermore, these apps did not limit their retention of PII and user data. Instead, they would claim to retain it for business purposes even after a user deletes their account, keep it for extended period of time, or use unclear and vague language regarding data retention. Some application did not provide notice on how long data would be kept, and how they would ensure the accuracy and relevance of the data collected they collected to ensure fairness.

Conclusion

This study highlights the fragile balance between innovation and data privacy protection in FemTech entrepreneurship in South-west Nigeria. The study recommends that FemTech entrepreneurs should engage with regulatory bodies to shape the core of data protection that balances innovation and user privacy and security and data integrity. Collaboration between the regulatory bodies and the FemTech entrepreneurs can lead to regulations that are conducive to technological advancements while ensuring that consumers' data are used responsibly. Entrepreneurs must also invest in strong cyber security measures, ensure regular security audits, encryption technologies and have a secure data storage practices that would guard against the risks associated with data breaches and unauthorized access. Transparency in how users' data is collected, used and protected would also build trust on the part of the user, the user would feel empowered to make informed decisions and this would contribute to a more secure Femtech ecosystem.

By implementing the recommendations outlined, FemTech entrepreneurs can contribute to a viable ecosystem that encourages technological advancements while safeguarding the privacy and security of user data. Eventually, achieving this balance is not only important for the success of FemTech ventures but also for building user trust and ensuring the continued growth of the FemTech Industry in Nigeria.

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**EXAMINING THE ELEMENTS OF UNETHICAL PROFESSIONAL
PRACTICES IN CONSTRUCTION PROCUREMENT IN NIGERIA: A
CASE STUDY OF BAUCHI STATE****¹Raji M. Mudashir, ²Shamsuddeen M. Maleka & ³Ibrahim
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Bauchi-Nigeria**²Physical Planning Unit, Federal Polytechnic, Bauchi-
Nigeria**³Department of Building Technology, Federal Polytechnic,
Bauchi-Nigeria**mrabi@fptb.edu.ng. 08036344112***ABSTRACT**

Public construction procurement is used as tool for developing economic, social and environmental wellbeing of a nation, as well as a strategic means for reducing unethical practices in the use of public funds. Nonetheless, Unethical professional practices negate the main objective of professional ethics; by implication unethical professional practices is a way that professionals disrespect the interest of their clients which translate to the wider public interest not recognized and respected. Hence, this study investigated the factors that constitutes unethical professional practices in public building procurement in Nigeria. Questionnaire survey was used to elicit data from public building professionals in Bauchi metropolis, Nigeria, through a disproportionate stratified random sampling technique. Analysis conducted shows no statistical difference in respondents mean scores on what constitute unethical professional practices. Factors of unethical professional practices were ranked to be moderately severe and severe. This study recommends stakeholders intending procedure adheres strictly to ethical requirements, public procurement Act be reviewed, improvement on conditions of public servants in Nigeria and appointment of credible leaders in public procurement agencies.

Keywords: Nigeria, professional practices, public building procurement, unethical

INTRODUCTION

Globally, public construction procurement is a relevant instrument of government policy and a lever for wider economic, social and environmental change, as well as a strategic profession that plays a central role in preventing mismanagement and minimizing the potential of corruption in the use of public funds (Kangogo & Kiptoo 2013). Yet, public procurement, a process used for the acquisition of public goods, works, and related services required in the execution of a project (Inuwa 2014), is still susceptible to unethical practices in most African countries (Kangogo & Kiptoo 2013; Jacob 2010; Sichombo, Muya, Shakantu, & Kaliba 2009). One of the stages in public procurement that is very vulnerable to unethical practice, according to Kangogo and Kiptoo (2013) is the tendering stage.

Unethical professional practices is a way that professionals disrespect the interest of their clients which translate to the wider public interest not recognized and respected (Owoyebi, *et al.* 2011). Studies conducted across the globe acknowledged that the consequences of unethical profesional practices in the construction industry is very detrimental to the technological and socio-economic development of any nation (Inuwa, *etal.* 2014; Abdul-Rahman, Wang, & Yap, 2010; Bowen, Pearl, & Akintoye, 2007; Harding, *et al.* 2004).

According to Sichombo, *et al.* (2009: 821) the fight against unethical professional practices in the construction industry has taken centre stage worldwide. This had informed many effort staken to increase the ethical standards and integrity among construction professionals that will ensure the attainment of VfM in their effort in delivering construction projects worldwide (Abdul-Rahman *et al.* 2010). Consequently, most developed countries and some developing countries, hadrealized that adhering to professional ethics during tendering procedure, is an inevitable pre-requisite to attaining VfM in the procurement of building projects (Abdul-Rahman *et al.* 2010; Ray, *et al.* 1999). Nonetheless, even with the enactment of public procurement Act in 2007 by the Nigerian government (Federal Government of Nigeria-FRN 2007), to curtail unethical practices, consequences of unethical professional practices in the tendering procedure of public building projects in Nigeria still abound (Jacob, 2010; Alutu&Udhawuve2009).

According to Mlinga (2006) the application of the highest ethical standards will help ensure the best achievable construction procurement out come, as well as enhance the procuring entities reputation in the marketplace. Unfortunately, construction procurement outcome in Nigeria is very dismal due to inexperience and fraudulent awards of contracts to wrong contractors through the perpetuation of unethical professional practices (Adebanjo 2012; Alutu 2007). Consequences of such action to a country could deny its construction industry of successful delivering of basic infrastructural projects that will support the country's economy (Abdul-Rahman, *et al.* 2010; Harding, *et al.* 2004). Adebanjo (2012) revealed that almost 60% offunds budgeted for public construction procurement in Nigeria end supportly on unnecessary administrative expenses and there stprobably in local and foreign accounts of individuals due to unethical professional practices. More alarming is a World Bank report in 2010 on Nigeria's procurement assessment, which revealed that about 50% of projects in Nigeria are dead even before they commence; projects are designed to fail because the

objective is not to implement, but to use them as vehicles for looting of public treasury. Instead of adding value, they become economic drainpipes (Jacob 2010: 132).

Inferences from studies conducted in Nigeria on construction professionals' ethics had indicated that the underperformance of the industry of not meeting project objectives of cost effectiveness, timeliness, quality, customer requirements, and health and safety, among other reasons emanate from unethical professional practices in the award of contracts (Inuwa, *et al.* 2014; Usman, 2012, *et al.* 2012; Oyewobi, *et al.* 2011; Ameh&Odusami, 2010). The outcome of this malpractice to the country has resulted in underdevelopment, deterring domestic and foreign investments, unemployment, undermining confidence in public institutions and exerting budgetary problems through inefficient revenue collection (Oladapo 2000). Even with the successes recorded in procurement requirements awareness and cost savings as a result of the enactment of the procurement Act in 2007 by the Nigerian government, evidences had shown that the tendering procedures of some public construction procurement projects amounting to over ₦20 billion were dented with blatant abuse of the procurement Act (see Anago 2012; Jacob2010).

Moreover, areview of studies one thics in the Nigerian construction industry failed reveal a study that centered on the identification of unethical professional practice during tendering procedures of public building projects, as well as the causes of its perpetuation and measures to curb it (Usman, *et al.* 2013; Ayodele, *et al.* 2011; Oyewobi, *et al.* 2011; Ameh&Odusami, 2010a; Ameh&Odusami, 2010b; Alutu, 2007; Ameh, *et al.* 2007; Inuwa, *et al.* 2014). Hence, the aim of this study is to investigate unethical professional practices in tendering procedure of public building procurement in Nigeria, with a view to improving professional ethics that will ensure VfM procurement of public buildings.

LITRETURE REVIEW

Concept of Professional Ethics and VfM Procurement

According to McNabb (2009), ethics is a branch of philosophy, that has evolved from a number of different philosophical traditions: over 5000 years ago in Egypt and Mesopotamia-present day Iraq; in Europe and United State of America (USA), codes of ethics have roots in Judeo-Christian tradition; in the Middle East, codes of ethics are founded on the Quran; in part of Asia, ethics springs from the teachings of either Confucius

or Buddha. Inferences drawn from all of these philosophical traditions revealed that ethics evolved as a set of moral standards that govern the conduct of an individual or a group of persons in an organizational or societal setting. McNabb (2009) defines ethics as the set of principles that govern the conduct of an individual or a group of persons, and briefly as the study of morality or moral behavior. Ethics according to Guthrie (2010), is a standard of professional behavior. In meeting this end, professionals involved in project procurement are expected to exhibit standard of professional behavior that ensures client get full value of what he paid for; VfM (Anago, 2012). Though it sounds simple, it is very complex in public procurement domain (Anago 2012). VfM mean services at lower cost, of better quality or a combination of these outcomes (Regan 2014). For procurement to satisfy VfM, it has to assess quantitative (or whole-life costs) and the qualitative attributes (or fitness for purpose) of a particular procurement decision (HM Treasury 2006 in Regan 2014). VfM assists professionals to guide client decision on which procurement method will deliver the best outcome, as well as on the most effective and efficient bidding method and process that will result in selecting the best bidder proposal that maximises public benefit.

The Emergence of a Procurement Law in Nigeria

Prior to 2007, there was no statutory provision that directly regulate the award of public contracts in Nigeria, hence the public procurement system had been grossly abused leading to high losses of resources (Jacob 2010; Ayangade, Wahab, & Alake 2009). Ironically, contract award in Nigeria is used as an avenue by which the government functionaries reward their friends and cronies and by which they too amass wealth, consequently negating the economic growth of the Nation (Jacob 2010: 131; World Bank 2000; Olatunji, 2008). More worrisome is that construction professionals who are trained and expected to exhibit high level of professionalism are not exempted from this moral decadence. They perpetuate unethical professional practices that culminate into flaws in the performance of public procurement (Usman *et al.* 2012; World Bank 2000). Studies had shown that public construction procurement performance in Nigeria, spanning decades after its independence in 1960, is marred with fraudulent practices perpetuated through either quackery or unethical professional practices (Adebanjo 2012; Usman *et al.* 2012; Oladapo 2000).

Disturbed with the devastating effects of unethical professional practices on the reputation and economy of the country, the Nigerian government commissioned a diagnostic study in 2001 to investigate the state of affairs of public procurement in the country. In a bid to nib

the menace in the bud the government set up a Due Process Unit under the presidency to undertake the exercise (Jacob 2010; Ayangade *et al.* 2009). Furtherance to its effort to sanitize and improve the public procurement performance, the government found it necessary to enact a procurement Law; thus enacted in to Law the public procurement Act in 2007 (Jacob 2010; Adebajo 2012). Though the introduction of the procurement Act in 2007 created awareness in the public domain on the essentials of procurement process and practice, and saved the nation over ₦300 billion in contracts over-pricing within the threshold of ₦1 billion by Ministries, Departments and Agencies. Nonetheless, its successes could not deter the perpetuation of unethical professional practices in the award of public construction contracts (Anago 2012; Jacob 2010).

One of the flaws in the Public Procurement Act is that it did not acknowledge the peculiarity and complexity of construction procurement and as such, rules in the Act covering procurement are applicable to procurement of goods, services and infrastructure. This should not be the case, as experts in construction procurement had for long acknowledged that it is 'a complex system, which may help to offer insights from the procurement of other types of complex systems (Hughes 2012:1). Its complexity is as a result of: its organizational structure; large size, expensive and risky; and takes longer duration to accomplish (see Hughes 2012:1). Moreover, core construction procurement professionals' roles are not spelt out and as such, consequences of their professional misconduct are not explicitly captured in the Act, hence making it difficult to convict erring professionals. The Act also failed to include the peculiarity of construction administration as required in the Joint Contract Tribunal (JCT 2005); a standard document which forms the basis of construction contract administration; stipulating rights and limitations of all stakeholders involved in construction procurement.

Element that Constitutes Unethical professional Practices in Tendering

According to Ramus, Birchall and Griffiths, (2006), tendering is an important matter that requires careful thought and execution if success is to be attained in the procurement of construction projects. Construction professionals engaged in procurement are expected to exhibit appropriate ethical requirements without fear or favour. Thus, their task in selecting a competent contractor focuses on selecting a contractor that: is financially stable and has a good business record, the size of the project is neither too small nor too large, has a reputation for good-quality

workmanship and efficient organization, and has a good record of industrial relations (Ramus *et al.*, 2006).

To achieve this end, tendering must be open, competitive and transparent. This will enable the client limited resources to be efficiently and effectively utilize to achieve VfM (Moneke, 2000). To demarcate what constitute unethical professional practices during tendering, one must be conversant with what constitute ethical professional practices in tendering. Ramus *et al.* (2006) identified preliminary enquiry, period for preparation of tenders, parity of tendering, opening tenders, and notifying tenderers as ethically recognized procedure for tendering. In addition, the Nigerian Public Procurement Act (FRN, 2007) identified advertisement, prequalification of tenders, and tender evaluation as a tendering procedure.

RESEARCH METHODOLOGY

This study is delimited to unethical professional practices in public competitive tendering.

Literature

review and unstructured interviews was used to design the questionnaire for the study. The questionnaire captured questions on respondents' demographic profile and the study objectives. Absence of an authoritative source for ascertaining the size of the target population informed the use of an accessible population (Oso & Onen 2011) of 180 building procurement professionals (architects, builders, engineers, and quantity surveyors). The accessible population are composed of professionally certified and experienced academic and non-academic staff in three tertiary institutions in Bauchi metropolis, Nigeria. Bauchi metropolis, occupy substantial landmass of the developed part of Bauchi, the capital city of Bauchi state; located in north-east Nigeria. It has a landmass of 49,119 km², a population of over 7 million people and has the highest concentration of construction activities in north-east Nigeria (Usman, *et al.* 2012;

NPC 2010). Sample size of 122 respondents was determined for the study using Krejcie and Morgan (1970) table. Cronbach's alpha (α) reliability test used to test the internal consistency of the questionnaire constructs record α values of 0.79 for factors that constitutes unethical professional practices. This result depicts that the questionnaire reliability status is good, since it is ≥ 0.70 ; hence the questionnaire is said to be consistent, reliable and free from random error (Sekaran 2003; Pallant 2001). In addition, experts in

the academia who specialized in construction and project management, verified and validated the study concept to be well represented by the items in the questionnaire, hence confirmed the content validity of the questionnaire (Sekaran 2003). Subsequently, questionnaire survey was conducted through disproportionate sampling technique, due to uneven population distribution (Dawson 2002). Respondents were instructed to use 5-point Likert scale to rank factors in the questionnaire.

RESULT AND DISCUSSION

The numbers of questionnaires distributed are 21, 53, and 48 in Abubakar Tatari Ali Polytechnic (ATAP),

Abubakar Tafawa Balewa University (ATBU), and Federal Polytechnic Bauchi (FPTB) respectively. The survey recorded % response rate of 90.48%, 79.25%, and 91.67% for the three institutions respectively, and an overall success response rate of 85.73%.

Respondents Demographic Information

Table 1 depicts the respondents' demographic profiles covering: sections in the institutions, educational

qualifications, educational specialization, professional registration, and years of working experience. The result shows that almost 84% of the respondents are academic staff while the remaining 16.2% are non-academic staff. These results show that majority of the respondents are responsible for the training of professionals and as such are well informed on the ethical requirements in practice. Majority of the respondents (91.4%) hold BSc and higher degrees; 10% are PhD holders, almost half of the respondents (47.6%) are master's degree holders, while 34.3% are degree holders. This result shows that majority of the respondents are educationally qualified to respond to research of this nature, and as such enhanced the validity of the research data.

Table 1 revealed that all the respondents (100%) specialize in core building procurement professions:

Architecture, Building, Engineering and Quantity Surveying (Ameh & Odusami 2010). This implies that the respondents are the core professionals engaged in public building procurement, and as such are knowledgeable and experienced to supply valid data for the study. Table 1 also shows that 90.3% of the respondents are professionally certified by their various professional bodies to practice. This shows that the respondents are qualified and

statutorily recognized to render their services in core building procurement transaction. Table 1 also revealed that the respondents have approximately an average of 18 years' experience working in the construction industry. These results confirmed that the data collected for this study is very valid because the respondent used are the most knowledgeable, experienced and appropriate to respond to the study area of enquiry.

Table 1: Respondents demographic profile

Sections in institution	No.	%	cumulative
Academic staff	88	83.8	83.8
Non-academic staff	17	16.2	100
Total	105	100	
Educational qualifications	No.	%	cumulative %
PhD	10	9.5	9.5
MSc	50	47.6	57.1
BSc	36	34.3	91.4
HND	5	4.8	96.2
Others	4	3.8	100
Total	105	100	
Educational specialization	No.	%	cumulative %
Architecture	19	18.1	18.1
Building	12	11.4	29.5
Engineering	60	57.1	86.7
Quantity surveying	14	13.3	100

Total	105	100		
Professional registration	No.	%	cumulative %	
NIA	12	11.4	11.7	
NIOB	12	11.4	23.3	
NSE	55	52.4	76.7	
NIQS	14	13.3	90.3	
Others	10	9.5	100	
Total	103	98.1		
Years of experience	Mid value (X)	Frequency	% of FX	
		(F)	F	
5-10years	7.5	6	5.7	135.0
11-16years	13.5	32	30.5	432
16-21years	18.5	49	46.7	906.5
Over 21years	21	18	17.1	378.0
	Total	105	100	1851.

5

$$\text{Mean years of experience} = \sum FX / \sum F = 1851.5 / 105 = 17.63 \approx 18 \text{ years}$$

Factors that Constitute Unethical Professional Practices in Tendering Stage

Table 2 shows the factors identified from literature to constitute unethical professional practices in tendering procedure of public building procurement, and the responses of the two groups of respondents (academic and non-academic staff) on the severity of the identified unethical professional practices. The significant level (probability) in Table 2 under independent sample t-test are all above the required cut off value of 0.05, this according to Pallant (2001) shows that there is no statistically significant difference in the mean scores of academic and non-academic staff on their ranking of the severity of unethical professional practice. This shows that both academic and non-academic staff agree that all the factors identified constitute unethical professional practices in tendering.

Hence, the null hypothesis that there is difference in means between academic and nonacademic staff on the factors that constitute unethical professional practices in tendering procedures of public building procurement in Nigeria was rejected. Both academic and non-academic staff ranked scores for the severity of the unethical professional practices to be moderately severe(3) and severe (4); favoritism during evaluation of tenders (4.2614 & 4.0588), connivance to award the contract to a party prior to tendering (4.1136 & 3.7059), deceitful advertisement (3.9886 & 3.5882), divulging confidential and vital tender information (3.8750 & 3.7059), and non-adherence to pre-qualification criteria (3.4886 & 3.5294) were ranked by both academic and non-academic staff to be a severe unethical professional practices. While informal procedure in opening tenders (3.2386 & 3.1765), non-conduction of preliminary enquiry (3.3295 & 2.9412), unrealistic duration given for preparation of tenders (3.2500 & 3.2529), deliberate disparity of documents to tenderers (3.3864 & 3.4118), and not notifying tenderers when tenders are to be opened (2.8636 & 2.6471) were ranked to be moderately severe.

Table 2: Severity of unethical professional practices in tendering procedure

S/N	Unethical professional practices	Acad.	Non-	Independent	
		Mean	Mean	<i>t</i> Stat.	Sign. Level
1	Connivance to award the contract to a party prior to tendering	4.1136	3.7059	1.15	0.27
2	Deceitful advertisement	3.9886	3.5882	1.19	0.25
3	Deliberate disparity of documents to tenderers	3.3864	3.4118	(0.09)	0.93
4	Divulging confidential and vital tender information	3.8750	3.7059	0.46	0.65
5	Favoritism during evaluation of	4.2614	4.0588	0.81	0.42

	tenders	4			
6	Informal procedure in opening tenders	3.238	3.1765	0.22	0.83
		6			
7	Non adherence to pre-qualification criteria	3.488	3.5294	(0.14)	0.89
		6			
8	Non conduction of preliminary enquiry	3.329	2.9412	1.39	0.17
		5			
	Not notifying tenderers when tenders are to be opened	2.863	2.6471	0.64	0.53
		6			
	Unrealistic duration given for preparation of tenders	3.250	3.3529	(0.31)	0.76
10		0			

Conduction of preliminary enquiry though not always practised according to Ramus *et al.* (2006), is a recommended practice. However, no empirical study was conducted in Nigeria to investigate the extent of its application and abuse in tendering procedure. Moreover, the severity of non-conduction of preliminary enquiry in relation to other unethical professional practice during tendering procedure was never assessed prior to this study. The implication is that there is high like lihood that contractors who are fully committed with other projects to submit a price far above the lowest tender, and if eventually awarded the contract, deliver the project without attaining VfM. It also signifies that prior notice on prospective contracts were never given to prospective tenderers, so as to enable them decide on whether they will be in a position to submit a bona-fide tender or not (Ramusetal.2006). Deceitful advertisement is also acknowledged by Attuh (2012), Jacob (2010), and Alutu (2007) as an unethical professional practice during tendering procedure. They all agree that most advertisement for inviting tenders for a prospective project in Nigeria is deceitful. However, no study focused on it empirically to ascertain its severity as an unethical professional practice in tendering procedure of public building procurement in Nigeria. This implied that there is no transparency and fairness in selecting contractors for public building procurement, thus resulting in selecting an incompetent contractor who

could end up delivering a project that has no VfM. Hence denying the public from benefiting from the needs the project is intended to address. Though this study and Ramus *et al.* (2006), acknowledged conduction of preliminary enquiry as a tendering procedure, and as such, its violation is regarded as an unethical practice, however the Nigerian public procurement Act was silent about it.

Unrealistic duration given for preparation of tenders is also an unethical professional practice during tendering in Nigeria, that concurs with Ramus *et al.* (2006) and Omole (2000) as a section that an unrealistic duration given for preparation of tenders is unethical. The implication of this result is that where tenderers are not given adequate time to prepare, and tenders prepared in a hurry might contain mistakes and flaws that could affect project success and as such deficient in given VfM. Not notifying tenderers when tenders are to be opened is also discovered as an unethical professional practice. It should be noted that notifying tenderers when tenders are to be open is an ethical professional requirement in tendering as recommended by Ramus *et al.* (2006) and other statutory organs of government (FRN 2007). However, where it is not adhered to, it constitutes unethical professional practice. Consequently, this study was able to reveal through empirical study the severity of not notifying tenderers when tenders are to be opened vis-à-vis other unethical professional practice.

CONCLUSION AND RECOMMENDATION

This study investigated the factors that constitute unethical professional practices in public building procurement in Bauchi metropolis, Nigeria, with a view to improving on construction professionals' ethics that will ensure VfM procurement. The study adopted exploratory and descriptive survey design. In addition, findings revealed that all the identified unethical professional practices were found to be moderately severe and severe. The implication is that contractors, consultants, and clients are all culpable in exhibiting unethical professional practices, and this needs to be addressed collectively by the contractor, consultant, and the client. There is need for stakeholders in tendering procedure of public building procurement to strictly adhere to ethical requirement in tendering procedure.

The study recommends: stakeholders in tendering procedure adhere strictly to ethical

requirements, Nigeria's public procurement Act be reviewed, improvement on conditions of public servants in Nigeria, appointment of credible leaders in public procurement agencies, and synergy between key public construction stakeholders for effective implementation.

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**THE ROLE OF INTERNET OF THINGS IN STREET LIGHT OPTIMISATION
USING SMART LIGHTING TECHNOLOGY****Shamsuddeen Usman^{1*}, Saidu Tasiu², Kabiru Usman Rogo³, Ahmed Abdulbasit⁴,
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ABSTRACT

The expense spent on street lights in various cities worldwide is quite large, due to high energy consumption and wastage by the conventional street lighting system. This is as a result of the inefficient use of those street lighting systems, as there are certain periods of time that those lights are not needed, especially on off-peak vehicular and pedestrian's period. The combination of the Internet of things (IoT), digital devices, sensors, actuators, software and Artificial intelligence has brought about a revolution in the way information is created, processed and disseminated. This phenomenon is widely referred to as Internet of Things (IoT). In order to minimize energy consumption, increase efficiency, reduce operational cost, and reduce environmental pollution, the optimization of the street lighting efficiency is an important feature that needs to be given attention. In particular, this service can optimize the street lamp intensity according to the time of the day, the weather condition, and the presence of people. This research work shall proffer an appraisal of the role of Internet of Things in street light optimization using smart lighting technology, which is very important to the Government, urban and regional planners, civil engineers and other stakeholders who are responsible for street lighting system management to understand the essence of street light optimization.

Keywords: Smart Street lightening; internet of things; Artificial intelligence; conventional street lighting.

1. Introduction

The Internet of Things (IoT) is a fast emerging and rapidly developing area of Information and Communication Technology. It is one of the most popular and trending buzz words of the IT industry nowadays. The Internet of Things (IoT) is the network of physical objects that contains embedded technologies to communicate and sense or interact with their internal states or the external environment (Internet of Things, n.d).

According to Brian U. (2014), Internet of Things (IoT) is a system or technology that allows devices to communicate directly with each other without human interaction. It allows device to device communication over the internet. Hence, paving the way for devices to share and utilize information. With Internet of Things (IoT), the world is changing into a smart

environment where tasks are automated, for example vehicles will automatically alert their owners when a tune up or part replacement is needed; energy consuming appliances will turn themselves on or off as needed, traffic light systems will allocate more time to parts with more traffic, and many other day to day activities.

The role of Internet of Things (IoT) spans across all social sectors like Education, Manufacturing, Government, Health, Security and many other areas of lifestyle and business. It also plays a huge role in emerging technologies like, Smart home, Smart cities, Smart grids, Smart lighting and many other automated technologies where devices interact with each other and share information.

The use of IoT in the future could result in a mix of information for the end-user and actions from smart things. If the ultimate objective is the automation of every possible process, including human behavior, applications will directly influence human actions by actuators in the network instead of communicating information to the user (Miorandi et al., 2012). This ultimate objective is more associated with something called a cyber-physical system (CPS). CPS and IoT are very similar concepts; they use the same kind of technology (wireless networks, sensors, cloud computing, etc.) and are used for the automation of processes. The only difference is that for CPS, the focus is on the actuation of objects, controlling physical entities (e.g. Logistics and production systems) and when talking about IoT, the focus is on the network structure used for the interaction of objects which allows the collection and integration of data (Minerva et al., 2015). This network structure is needed for the actuation of different objects in CPS systems.

One area where Internet of Things (IoT) plays a major role is street lighting, where energy consumption by street is optimized through Smart lighting technologies, which allows street lights to turn on or off when needed, in order to minimize energy consumption or find broken lighting appliances. It is also used to optimize energy consumption and increase efficiency in street lights.

Street light refers to a system of lighting where light is used to illuminate roads or path, typically mounted on a tall lamp post or pole. This system is used in many cities around the world, to provide lighting, road safety, pedestrian safety, security and other luminary services. Despite, these positive advantages of street lights, the major problem associated with them is their high energy consumption which leads to their increased operation and

maintenance cost. To solve this problem, the smart lighting technology was introduced. The Smart lighting technology allows the automation of lighting appliances, thereby allowing automated control of lights using sensors or internet applications. This technology helps in saving energy by allowing the lights to be dynamically adaptive and responsive to ambient conditions through information exchange by the lighting devices (Bahga&Madiseti, 2014).

By adding internet connectivity or Internet of Things (IoT) to the smart lighting systems, there is increased efficiency in the functionality of these systems. The lighting systems can now communicate with each other, exchange information, and respond to environmental changes. For example, a smart street light connected to the internet and embedded with sensors can automatically turn itself on when it senses movement of a vehicle or pedestrian or turn itself off or reduce its lighting intensity i.e. dims the light when it senses that there are no vehicles or pedestrians on the street. It can also send information about broken lamps that need to be fixed, based on the information it gathers from each of the lamps, and many more tasks that will increase its efficiency, minimize its energy consumption and operations cost.

Against this background, this research seeks to investigate the role of Internet of Things (IoT) in street light optimization using the Smart lighting technology. It looks at how this emerging technology will help in optimizing street lights, thereby reducing energy consumption, making them more efficient, and less expensive.

2. Review of Related Literatures

Street light is a lighting system used in illuminating road or path using typically mounted tall lamp posts or poles. It is a system of lighting our roads, streets, pave ways, etc., that is found almost everywhere around the globe.

According to Luckiesh M. (1920), the use of street lights was first recorded in the city of Antioch, an ancient Greco-Roman city whose ruins now lie in modern city of Antakya, Turkey, and uses the name Antakya. Garrison F. (1929) and Scott P. (1904) agreed that the use of street lights was recorded in the Arab Empire in the 9th-10th century, and Scott P. (1904) added that especially in Cordova city in southern Spain.

According to Bullough, John, MS Rea & Y Akashi (2009), Modern Street lights were reported to have become popular after the Second World War, later on the smart LED street lights were invented.

2.1 Problems associated with traditional street lights

There are many problems associated with our traditional street lights, but the major ones are highlighted below:

- High cost of operation and maintenance.
- High energy consumption & Carbon emission.
- Power outage and breakage of lighting appliances

The environmental impact factor of traditional street lighting system is a big concern; the high-intensity-discharge (HID) has remained largely used for street lighting systems until recently when there is now an increase in the use of Light Emitting Diode (LED) lamps due to the need to conserve energy, cost, and environmental impact factors. (Leena, 2015)

The energy usage of a typical street lighting system can be huge since the streetlights remain lit during operational hours (about 12 hours daily).

In the United States for instance, about 22% of electricity generation is used on lighting applications, street lighting takes a significant portion of this. (Kelvin Ochs, 2012)

In another study, the street lighting system is reported to be consuming 40% of the total available energy in cities (Ozadowicz, 2017). This is a huge strain on the limited available energy in a country like Nigeria with a population of about 190 million (World-Bank, 2018) but with only 7000MW of power generation (Federal Ministry of Power, 2018). It is essential to optimally utilize the limited available power for such a large population.

Like every equipment or machine, the streetlight also requires maintenance. Generally, there are two kinds of maintenance actions in the street lighting system: Preventive Maintenance and Corrective Maintenance (Lee, 2016)

Preventive Maintenance deals with the replacement of installed items after a scheduled time and Corrective Maintenance is about replacement of failed items. Some literature has shown that the implementation of Preventive Maintenance on stochastically failing items can help to extend their life span and reduce operating cost (Chelbi, 2004).

The Preventive Maintenance is not exclusive to the replacement of failed bulbs after a scheduled period. It also involves the implementation of other measures such as traditional physical inspections and automated control systems for remote monitoring and management that can lead to a reduction in power consumption, maintenance, and running cost (Galatanu C, 2019)

2.2 Smart lighting

Smart lighting is a lighting technology designed to reduce energy consumption by lighting appliances and increase efficiency. It allows remote control of lighting appliances to suit the users need. Usually sensors and chips are embedded into these lighting appliances. The sensors and chips are usually embedded with some computational intelligence that increases the efficiency of the working of such appliances.

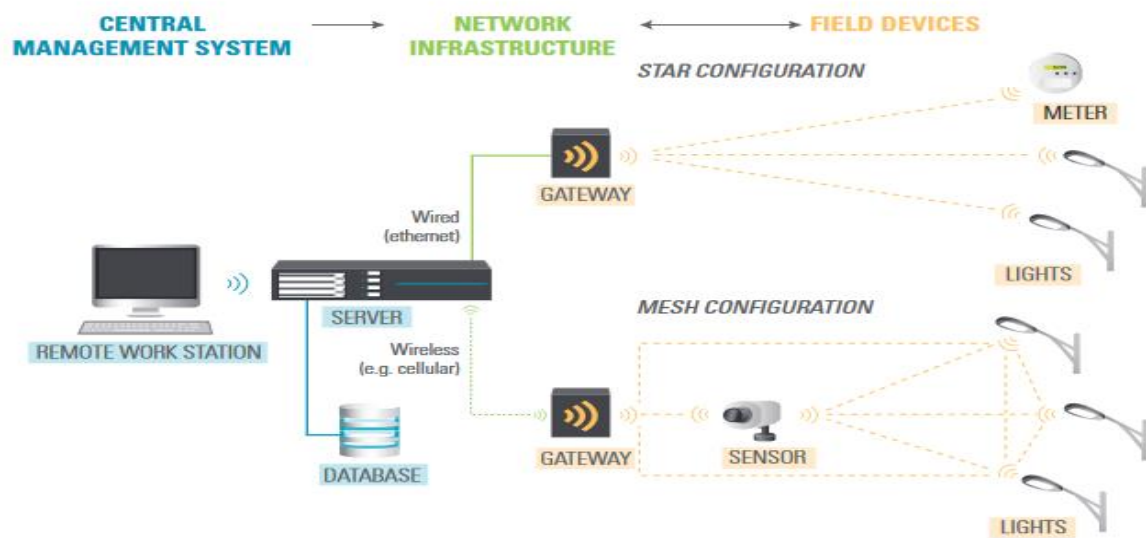


Figure 1: Smart Street Lightening.

Smart lighting technologies like the LED (Light-emitting diode) technology were designed to optimize the use of all lighting appliances. LEDs produce light by different physical processes than conventional lighting source; LEDs are highly directional, spot sources. Light is emitted from a very small surface area on the LED chip so the output must be diffused using secondary methods such as lenses or reflective optics. (California University, 2015)

The sensor or chips embedded in these lights are powered with computational intelligence that allows these lights to dynamically adapt to and respond to the environmental changes around them.

There are many advantages to using LED technology as compared to traditional incandescent, fluorescent or high-intensity sources. (California University, 2015)

1. The lifetime of an LED product is significantly longer than most alternatives, which reduces product replacement, maintenance and recycling costs.

2. LEDs are fully dimmable, last longer when dimmed, and are not affected by ON-OFF cycling, which makes them well suited for use with lighting controls solutions.
3. LEDs are good for certain applications in cold environments, since efficacy and life both increase with lower operating temperature.

High-quality LED lighting improves the quality of life in the city by providing the right light that makes the streets brighter and safer. Providing solutions that will be modern, efficient, and energy-saving at the same time and human-friendly. (Konrad Henryk Bachanek, 2021)

Advanced LED lighting solutions (including efficient use of luminaires) include integration with cloud computing to deliver real-time data to central servers. It provides real-time information on movement, temperature, brightness, and air pollution. Integration with the relevant application allows the monitoring of different parameters of the urban system. Luminaires installed in pedestrian areas work in synchronization with motion sensors, which ensure that the lamps do not shine with full force when no one is near them. Each of the luminaires can be remote-controlled, and data on the technical condition of the infrastructure is also transmitted to the system on an ongoing basis, thanks to which any faults are detected almost immediately. (Konrad Henryk Bachanek, 2021)

3. Methodology.

The study adopted the concept of qualitative research approach as a methodology of choice, because this methodological choice is straightforward since the subject of the research question is qualitative in nature and there are only a few companies that use Internet-of-Things (IoT) applications specifically in Street lighting worldwide, because it's still an unknown domain which limits the possibilities for quantitative research.

This methodological approach used for data acquisition involving fact finding, face-to-face interview with all stakeholders and all staff under the Street lights monitoring department of the Ministry of Works Kano State, Nigeria. Kano state is an ancient city located in North-Western Nigeria.

3.1 Method of Data Collection

This section highlights the details on the study location, research design, sample population, method of data collection, source of data, and method of data analysis. Physical/hardcopy questionnaires were disseminated to respondents and retrieved personally from

therespondents. This is because it is more suitable in gathering a wide range of information from a wider range of respondents. However, secondary data were also collected through current textbooks, Journals, Newspaper, Magazines and notable databases like Emerald, ScienceDirect, and Scopus.

For the data analysis, a Likert scale was adopted. Likert scale is an orderly scale from which respondents choose the option that best supports their opinion. Though the responses may be perceived as subjective or biased, yet, it measures the extent to which a respondent agree or disagree with a particular question or statement. Likert scale questions as presented in Table 2, are one of the most widely used tools in researching popular opinion; they use psychometric testing to measure beliefs, attitudes and opinion.

The question comes in form of statement, and respondent then indicates how much they agree or disagree with the statement. And one of the major advantages of using Likert scale questions is that they use a universal method of collecting data, which is easy to understand and to draw results and conclusions from the responses received.

Table 2

Sample of Likert Scale Questionnaire

S/N	Statements	Strongly Agree	Agree	Undecided	Disagree	Strongly disagree	Weighted score	Ranking
1	Statement 1							
2	Statement 2							
nTerm	Statement n							

4. Results and Discussion.

The result, analysis, and discussion from the survey questionnaires and interviews obtained from the study respondents are presented in sections 4.1 and 4.2. The results have generally

indicated skepticism, lack of awareness for the implementation of Internet-of-Things (IoT) technology in street lightening.

4.1 Characteristics of the Study respondents

In this study, a total of one hundred (100) questionnaires were distributed to all the staff members under the Street Lights Monitoring Department (SLMD) of the Ministry of Works Kano State, with each having thirty eight (38) questions. And fifty seven (50) out of the one hundred (100) questionnaires administered were properly completed and returned, indicating a return rate of 50.00%.

Based on the responses obtained from the questions raised in the questionnaires, Table 3 presents the bio data and characteristics of the respondents in frequencies and percentages.

Table 3

Characteristics of the respondents

S/N	Variable	Frequency	Percentage
1	Sex:		
	(i) Male	44	88.00%
	(ii) Female	6	12.00%
2	Age:		
	(i) Below 30 years	20	40.00%
	(ii) 31-50 years	30	60.00%
	(iii) 51 years and above	0	0.00%
3	Marital Status:		

(i) Single	40	90.00%
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(ii) Married	10	10.00%
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4 Educational Qualification:

(i) Post graduate	1	02.00%
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(ii) Graduate	26	52.00%
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(iii) Diploma/ NCE	23	46.00%
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(iv) SSCE/WAEC	0	0.00%
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5 Working experience:

(i) 1-4 years	4	08.00%
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(ii) 5-9 years	18	36.00%
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(iii) 10 years and above	28	56.00%
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6 Department:

(i) Admin	10	02.00%
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(ii) Technical	15	30.00%
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(iii) Marketing	4	08.00%
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(iv) HR	2	04.00%
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(iv) Others	19	38.00%
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Table 3 revealed that male respondents constitute the largest portion of the respondent (i.e.) 88.00% while more than 60% of the total respondents were aged above 30 years. In terms of marital status, the number of singles and married constitute 90.00% and 10.00% respectively. More so, the analysis revealed that most of the respondents are graduates, as they constituted more than 52% of the total number of the respondents. However, by working experience the largest portion of the respondents (i.e. 56.00%) has work experience between 10 years and above, and 18 (36.00%) between 5-9 years, while 4 (8.00%) have work experience between 1 to 4 years. Moreover, the analysis showed that most of the respondents were from technical department (i.e.30.00%).

4.2 Parameters affecting adoption of new/modern technologies in street lights

The instrument used contained forty (40) questions out of which thirty eight (38) were Likert-type statements while the remaining two (2) were open-ended type. The responses obtained from the first set was rated using 5 points Likert-type rating scale, in which “strongly agree” is scored = 5, agreed scored = 4, undecided scored = 3, disagreed scored = 2, while “strongly disagree” scored = 1. Table 2 presents the obtained result base on the responses.

Table 4

Assessing the level of effectiveness and efficiency of the current street lighting system.

S/No	Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly disagree	Weighted score
1	Our current street lighting system has no issue worth addressing, customers are happy about the services they receive.	4	5	0	18	23	99
2	We can also meet-up with the developed countries in terms of steady power supply using our current street lighting system.	7	24	1	13	5	165

3	We auto-detect power outage, and other faults in our street lights.	1	5	4	19	21	96
4	We have best troubleshooting process & standard monitoring unit that response to power outage without receiving complain from people.	0	8	0	12	30	86
5	We always receive good feedback from people regarding the services we provide.	6	12	8	12	12	138

Table 4 presented and analyzed the responses obtained from the specific statements formulated in the questionnaire to provide answer to the first research question. Generally, the analysis indicated a significant support for all the statements, with statement number two (2) having the greatest support (weighted score = 165).

However, statements number five (5), one (1), and three (3) followed in that order, while statement number four (4) became the last (i.e. in terms of the level of agreement by the respondents) with weighted score of 86. Hence, the analysis revealed a relatively high level of confidence in the ability to meet up with developed countries in terms of steady power supply to our street lighting system, however, the detection and response to problems in the street lighting system is not automatic, as staffs have to be mobilized to detect, analyze and solve the problem. Whereas, the smart street lighting system proposed by this research has self-detection and real time response capabilities.

Table 5

Extent of willingness by stakeholders to adopt new technologies for street lights

S/N	Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly disagree	Weighted score
6	There is need to alert stakeholders on the benefits of adopting new technology in	21	23	2	4	0	211

	the street lighting sector.						
7	I am in support of modernization and upgrade of our street lighting systems to smart lighting systems.	21	19	6	4	0	207
8	The adoption of new technologies as obtainable in developed countries is the only solution to our current system of street lighting.	9	20	5	11	5	167

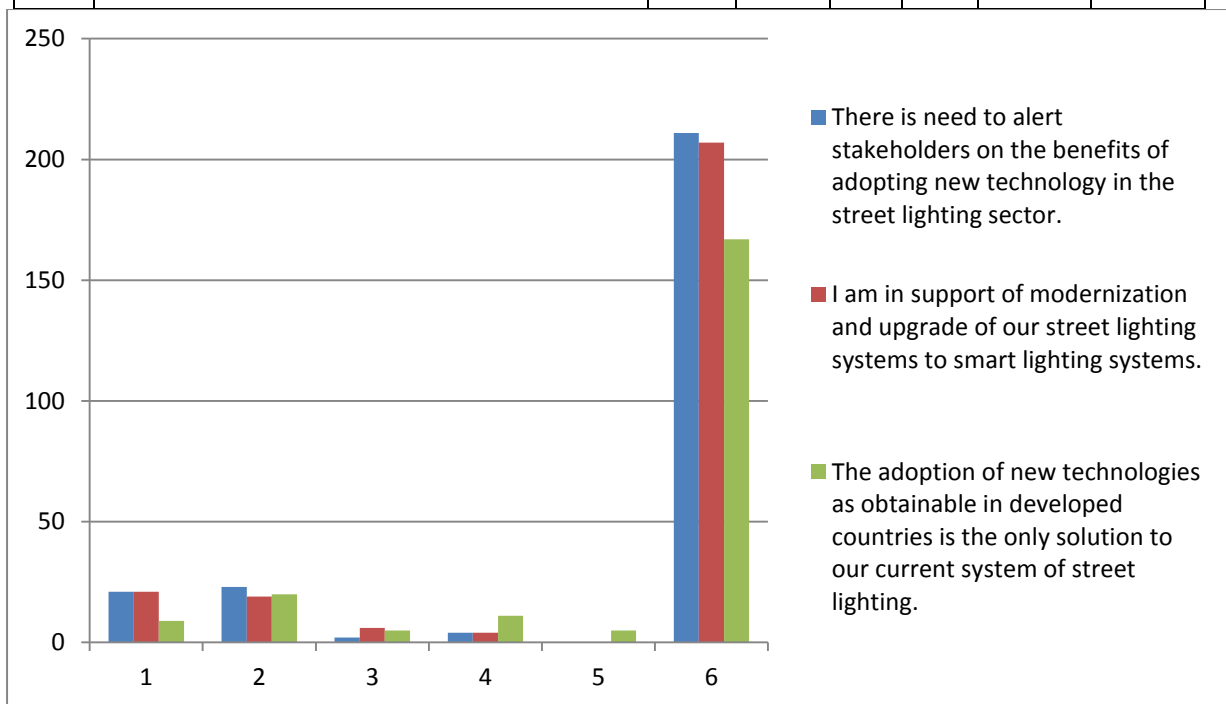


Figure 2: Extent of willingness by stakeholders to adopt new technologies for street lights

Figure 5 analyzes the extent to which stakeholders are willing to adopt new technologies that will enhance the current street lighting system. Most of the respondents were of the belief that there is need for stakeholders to be alerted on the benefits of adopting new technologies that will enhance street lighting sector. Also, many of the respondents believe that are in support of modernization and upgrading of our current street lighting system to smart lighting systems. However, few of the respondents were of the belief that new technology is the only solution needed to upgrade our street lighting system. Hence the graph indicates the extent to

which stakeholders are willing to adopt new technologies in order to optimize our street lighting system.

Also in Table 5, the response obtained using the specific Likert-type statements in the questionnaires meant to provide answer to the fourth research question. From the foregoing table, it indicated that stakeholders are optimistic of the fact that new technologies and adoption of an upgraded power infrastructure will certainly ensure steady power supply that will favorably compete with that in the developed countries. In many spheres the adoption of new technologies had resulted in an unprecedented improvements in our daily lives, for instance, in the Information and Communication Technology, the use of mobile GSM phones has increased efficiency in doing business, tracking criminals, prompt communication etc., also, in the electronic arena, we moved from cathode ray tube, to black and white television, to colour television, to plasma LCD, LED and smart television and a lot other areas. Virtually, it is only in the Nigerian power sector that new technologies are not utilized to enhance conventional power generation, transmission and distribution system, though, the use of solar, wind, nuclear and thermal energy is now gaining recognition in the Country. The data in table 5 above indicated that the respondent believed that adopting new technologies is not the only solution to the power sector problems, thus, 3rd in the ranking.

Table 6

Ascertaining the level of awareness about Internet of Things (IoT) among stakeholders

S/N	Statement	Strongly	Agree	Undecided	Disagree	Strongly	Weighted
9	I have an idea about what the concept of Internet of Things entails.	0	21	15	14	0	157
10	Internet of Things based street lighting system focuses on smart electrical energy generation with intelligence supply, which responses to power fluctuations by controlling the	21	23	2	4	0	211

	electrical energy sources						
11	Internet of Things based street lighting system transmits energy via transmission network which route energy from various sources to destinations via the best possible available route	21	19	6	4	0	207
12	Internet of things based street lighting system can provide efficient and effective alt system of street lighting better than the current system.	24	7	1	13	5	182
13	I think alerting all stakeholders to know about the benefits of adopting Internet of Things and Smart lighting technology for street lights will be a good idea	25	21	1	3	0	218

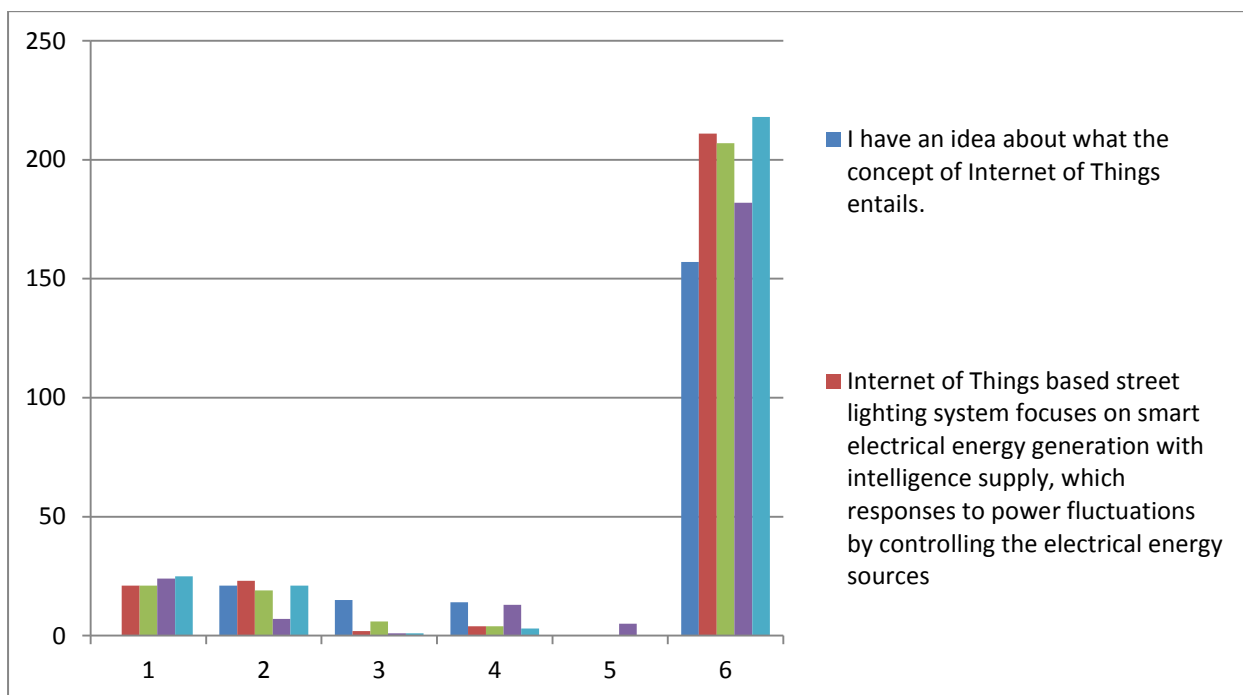


Figure 3: Ascertaining the level of awareness about Internet of Things (IoT) among stakeholders

Figure 3 ascertains the level of awareness about the concept of Internet of Things (IoT) among the respondents. Most of the respondents are of the opinion that it is a good idea to tell the stakeholders what Internet of Things (IoT) is in the first place. While a minority of the respondents said that they know what Internet of Things (IoT) is. This shows that the level of awareness is low, hence the reason why it is not known by many of the stakeholders.

Table 6 indicated respondents were largely of the view that with increased awareness of the benefits of the Internet of Things (IoT) among major stakeholders will obviously leads to its wholehearted adoption and usage by both the producers and customers alike. Thus, this view became the 1st in the ranking of the analysis of table 6 above, which corroborates the major aim of my research. This opinion is a good omen towards shifting from the traditional system, which stakeholders were already pessimistic and skeptical of its capabilities in enhancing power supply, due to the fact that, in spite the numerous attempts by various governments in sinking funds in the sector couple with the technical effort of improvement by engineers in the sector, yet, it is still in oblivion whilst other countries that are still considered to be in the “third world” like Morocco, Cotonou, Libya, Egypt etc., do celebrate decades of steady uninterrupted power supply.

The 5th ranking in the Likert scale of table 6 indicated unawareness of the Internet of Things by respondent, however, on explaining to the respondent what Internet of Things was and its versatility in responding to power fluctuations by controlling the electrical energy sources, they became optimistic on its applicability and success, thus, 2nd in ranking. Though, even with their optimism, they seems not to agree on the fact that it has a safe healing capabilities in solving transmission faults and also to switch among best possible routes to supply the end user with light automatically – because the transmission lines are digital and equipped with IP addresses. The aforementioned reason makes this view to rank the fifth (4th) in the table above.

Table 7

Improve street light energy utilization by Internet of Things

S/No	Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Weighted
14	Smart lighting technology will play significant role in boosting power needed to meet up with the ever growing demand.	30	12	0	8	0	214
15	Internet of Things can help in improving renewable Energy utilization by channeling it from different remote locations & sources to the street light lines.	12	12	8	12	6	162
16	The role of Internet of Things in street light optimization is a positive initiative.	35	10	0	2	3	222
17	I think the cost of using this technology is relatively cheap.	12	12	0	24	2	158
18	I think the use of Internet of Things in street light optimization is feasible.	35	10	0	2	3	222
19	I think the use of Internet of Things in street lights will be dominant in the nearby future	12	10	6	12	10	152
20	I think the issue of security and privacy of data will hinder the use of Internet of Things based street lighting system.	24	26	0	0	0	224
21	I think the issue of network failure and broadband problems will hinder the implementation of this technology in Nigeria.	23	17	0	7	3	200

22	I think the efficiency of Internet security measures can help prevent security, privacy and data breach.	22	18	0	6	4	198
23	I think the use of low energy wireless will tackle network and broadband problems.	21	19	0	5	5	196
24	I think lack of technical know-how of the usage of Internet of Things based applications and devices will hinder the implementation of such technology.	25	21	0	2	2	215
25	I think Hands-on Training on Internet of Things application development will solve the problems associated with the implementation of this technology.	24	16	0	4	6	198
26	Some Internet of Things hardware devices are hard to acquire in Nigeria.	23	22	0	3	2	211
27	The adoption of this technology by major companies and stakeholders is essential to the progress of its implementation.	22	27	0	1	0	220
28	Internet of Things will help optimize street lights and reduce cost and energy consumption.	21	20	0	4	5	198
29	I think the addition of computational intelligence, network connectivity, and storage to street lights is the basis for implementation of this technology.	20	16	0	6	8	184
30	The role of Internet of Things in street light optimization cannot be over	19	27	0	0	4	207

	emphasized.						
31	The government wasted time relying on the current street lighting systems despite the energy wastage experienced using it?	20	25	0	2	3	207
32	Nigeria or African countries in general are afraid of adopting this new technology.	20	20	0	5	5	195
33	Most people have never heard of the term Internet of Things.	20	23	4	0	3	207
34	Experts find it hard to describe the term Internet of Things.	10	24	8	8	0	186
35	I foresee (more) possibilities with this technology for the improvement in street light optimization.	12	28	2	2	6	188
36	I think collaboration with other organizations will be necessary to realize this evolution	20	19	6	0	5	199
37	More enhanced IoT enabled applications will be developed in the near future.	12	20	8	5	5	179
38	The evolution of this technology in street lights is feasible.	20	20	8	0	2	206

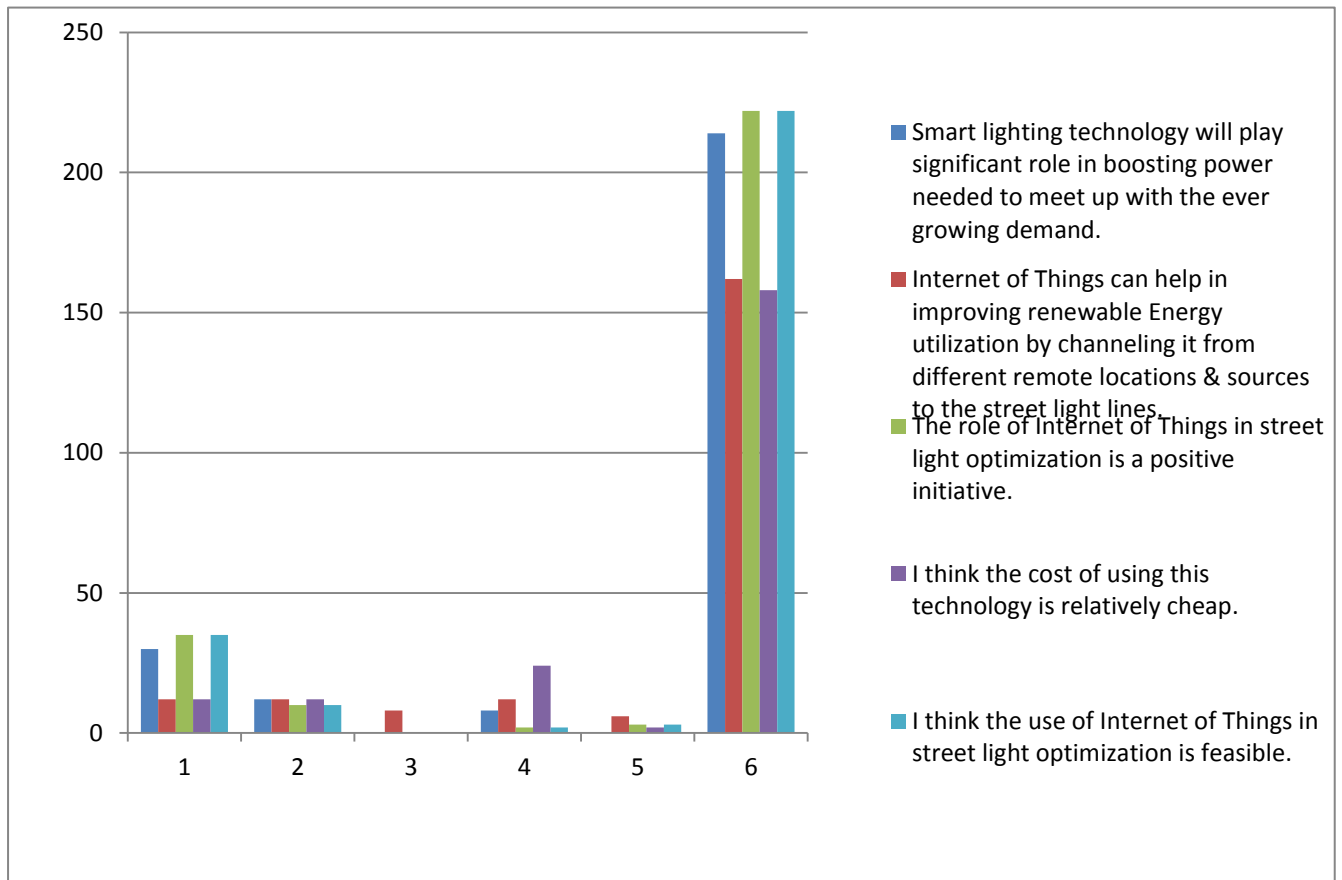


Figure 4:Improve street light energy utilization by Internet of Things

Table 7 indicated respondents were largely of the view that Smart lightening technology will surely play significant role in boosting power needed to meet up with ever growing demand and believed that the role of Internet of Things in street light optimization is a positive initiative, but also thinks that security issue and privacy of data can probably be a drawback factor that can hinder the use of Internet of Things based street lighting system.

Conclusively apart from the fifteen (15) Likert-type statements, two (2) additional open-ended questions were raised in the questionnaire mainly to help generate more opinions from the respondents so as to facilitate better conclusion and recommendations. Though, the views of the respondents were divergent, yet, majorities were of the view that Nigerian Government and stakeholders in charge of street lights should subconsciously adopt Internet of Things based Technology.

The figures in the subsequent pages illustrate the opinions of the respondents based on the question that were administered in the questionnaire.

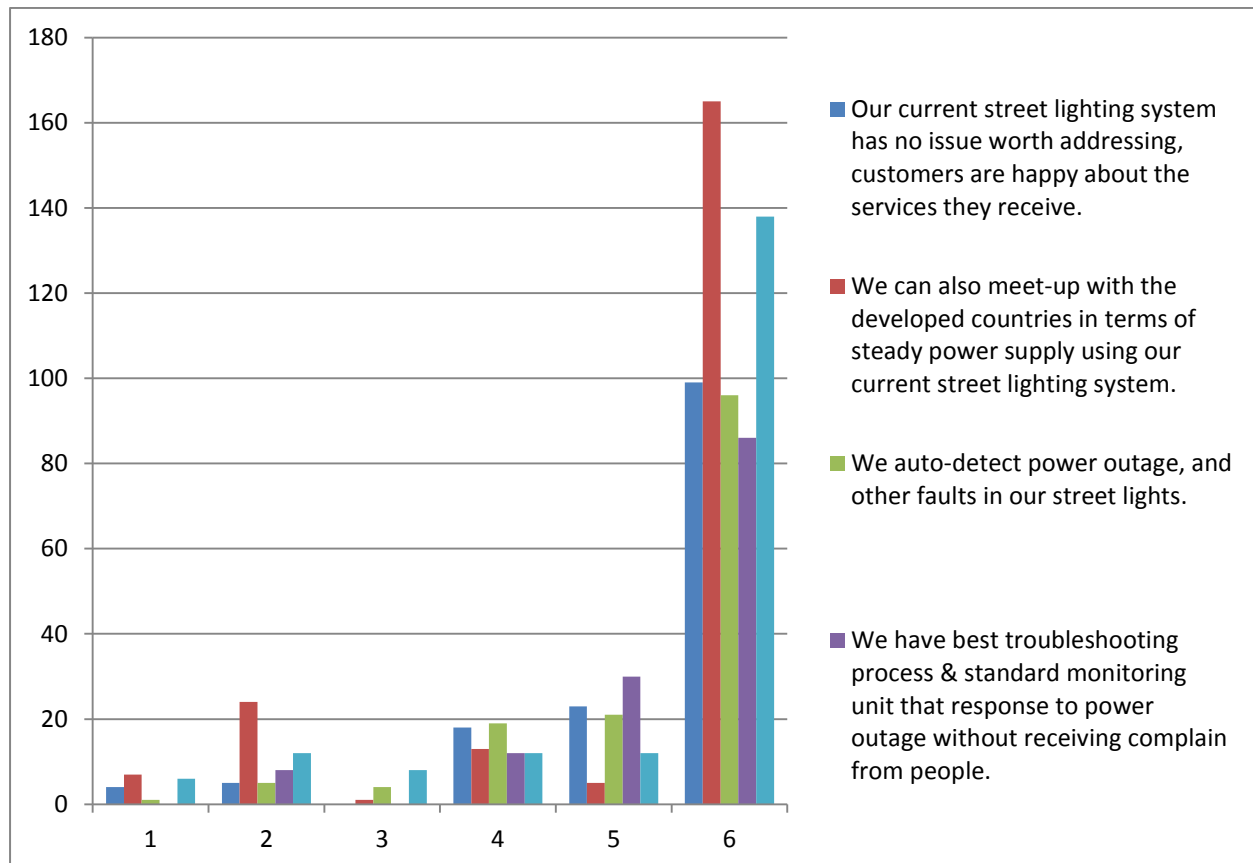


Figure 5: Assessing the level of effectiveness and efficiency of the current street lighting system

From figure five (5) we can clearly see that majority of the respondents believed we can meet up with developed countries in terms of steady power supply using our current street lighting system, on a weight score of 165, while a minority were of the believe that we have the best troubleshooting process and standard monitoring system for our street lights. The graph indicates the responses of the respondents for question one to five of the questionnaire.

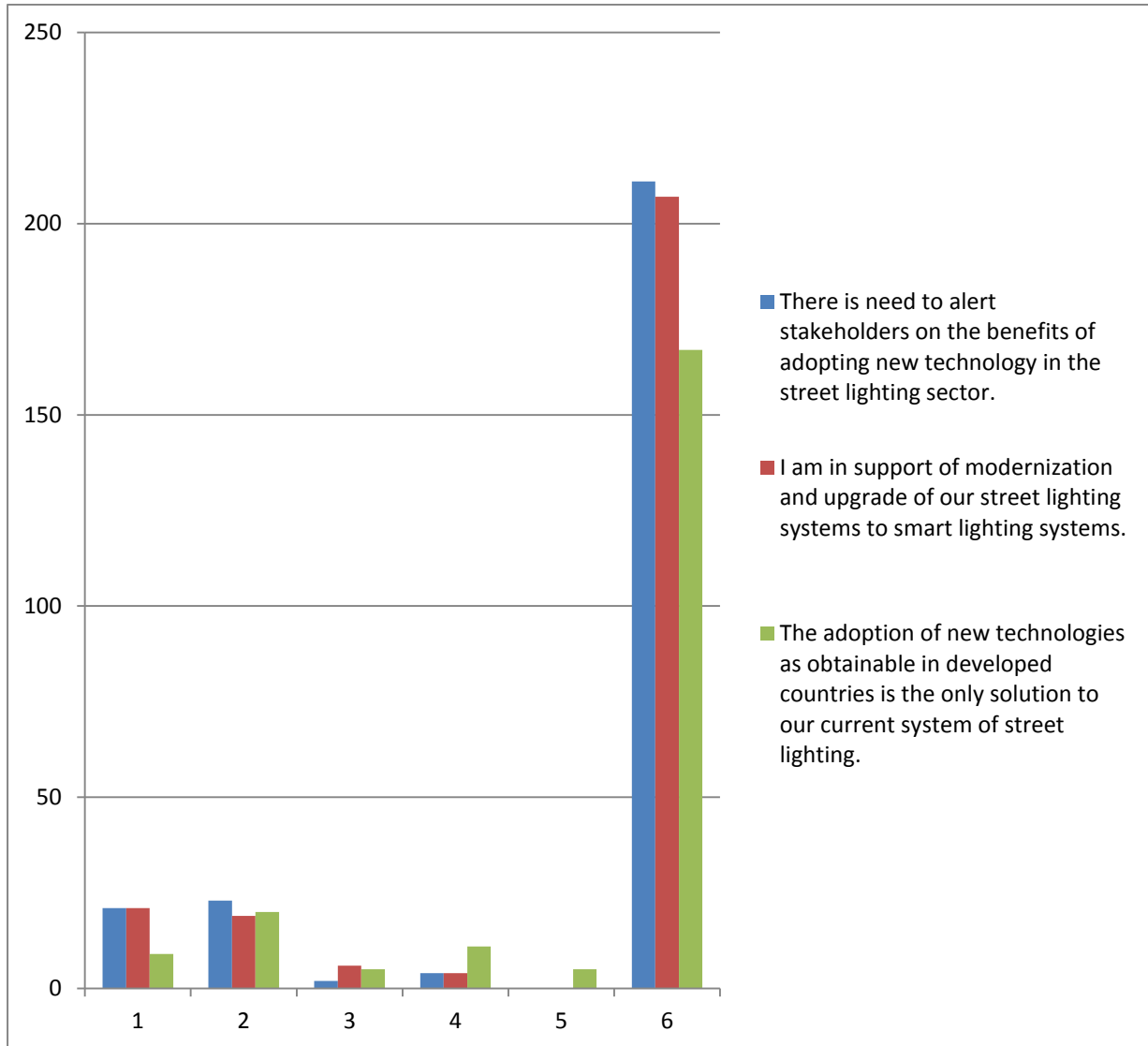


Figure 6:Extent of willingness by stakeholders to adopt new technologies for street lights

Figure 5 analyzes the extent to which stakeholders are willing to adopt new technologies that will enhance the current street lighting system. Most of the respondents were of the belief that there is need for stakeholders to be alerted on the benefits of adopting new technologies that will enhance street lighting sector. Also, many of the respondents believe that are in support of modernization and upgrading of our current street lighting system to smart lighting systems. However, few of the respondents were of the belief that new technology is the only solution needed to upgrade our street lighting system. Hence the graph indicates the extent to which stakeholders are willing to adopt new technologies in order to optimize our street lighting system.

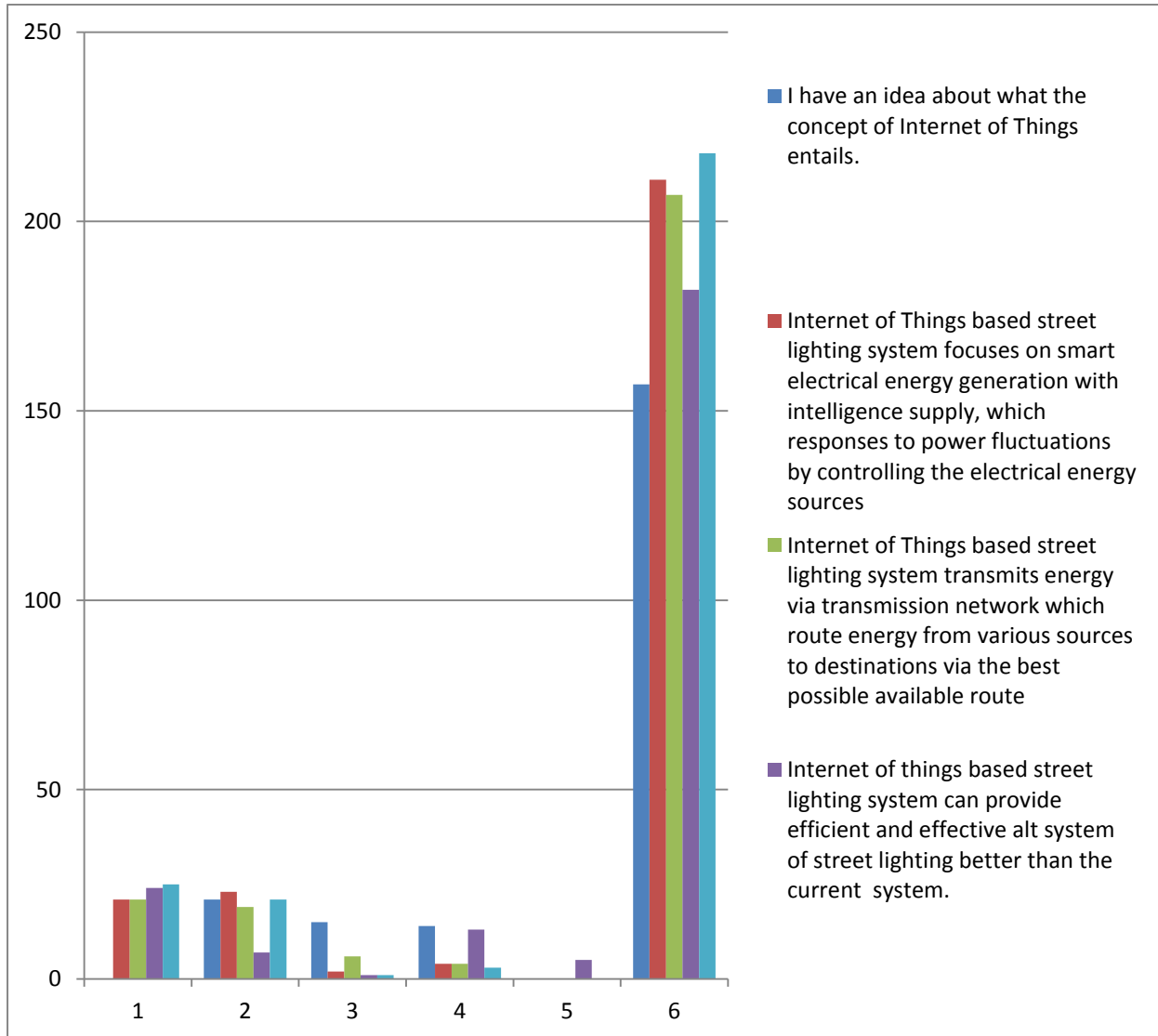


Figure 7: Ascertaining the level of awareness about Internet of Things (IoT) among stakeholders

Figure 7 ascertains the level of awareness about the concept of Internet of Things (IoT) among the respondents. Most of the respondents are of the opinion that it is a good idea to tell the stakeholders what Internet of Things (IoT) is in the first place. While a minority of the respondents said that they know what Internet of Things (IoT) is. This shows that the level of awareness is low, hence the reason why it is not known by many of the stakeholders.

Figures 8 to Figure 12 all analyzed how Internet of Things (IoT) can play a role in improving street light utilization or optimization. After explaining what Internet of Things (IoT) is to the respondents.

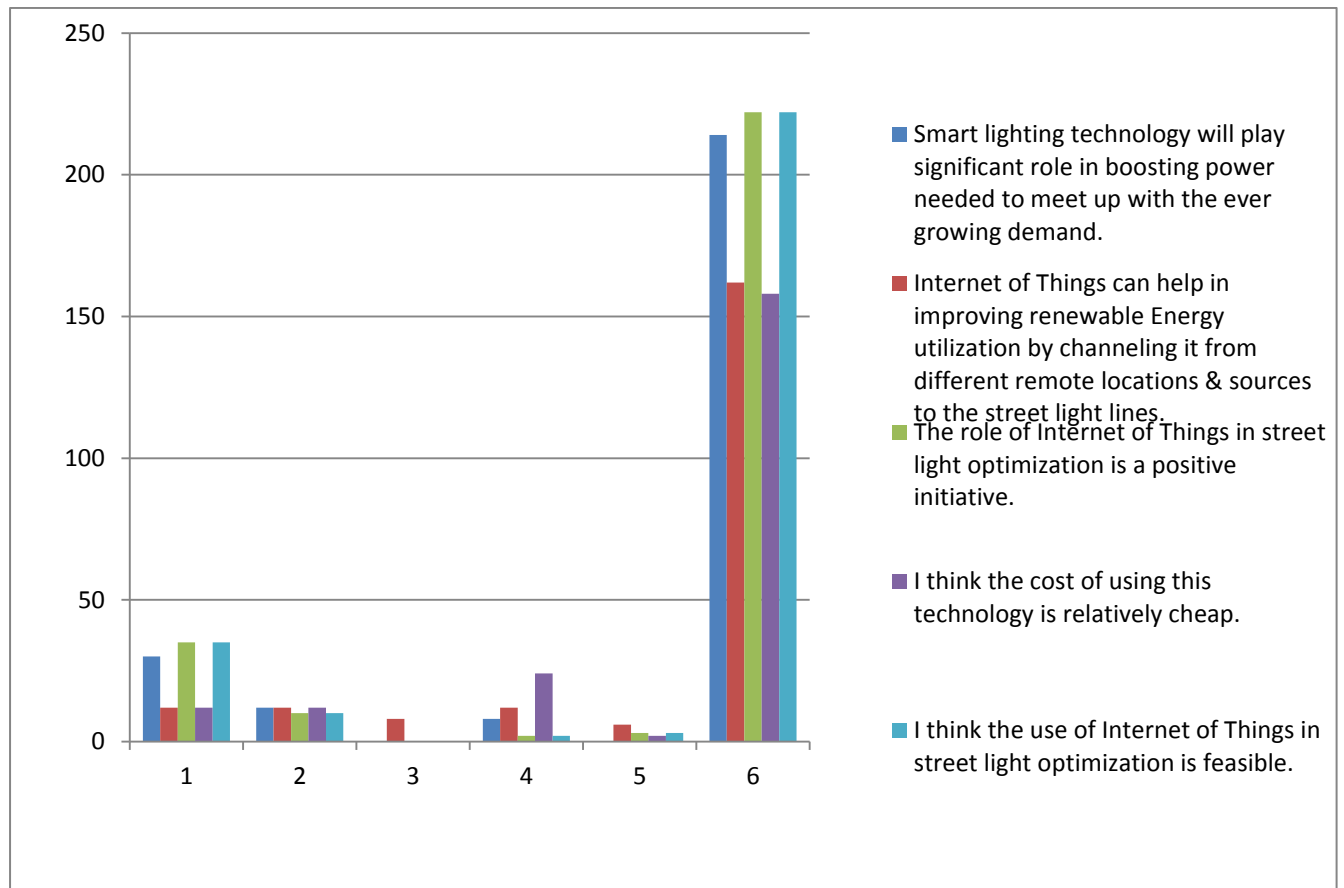


Figure 8: Improving Street light energy utilization by Internet of Things

Figure 8 shows that Internet of Things based street lighting system implementation are feasible. While only few believe that it is relatively cheap to implement.

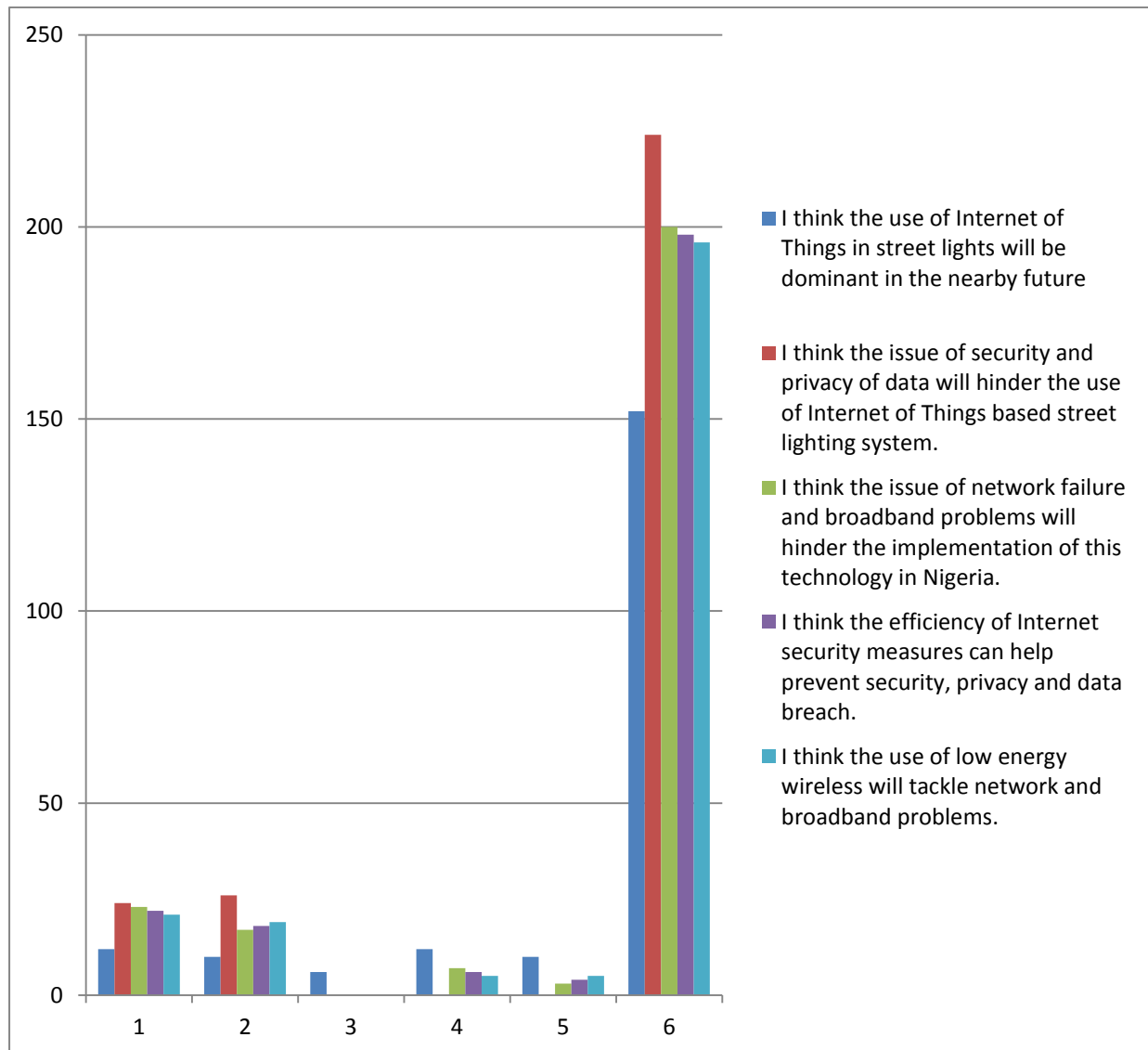


Figure 9: Improving Street light energy utilization by Internet of Things

Figure 9 shows most of the respondents believe that security and privacy breach will hinder the use of Internet of things (IoT) based street lighting system, as network security is a very important factor in its implementation. It also shows that a few of the respondents are of the opinion that it might be the dominant technology in the nearby future.

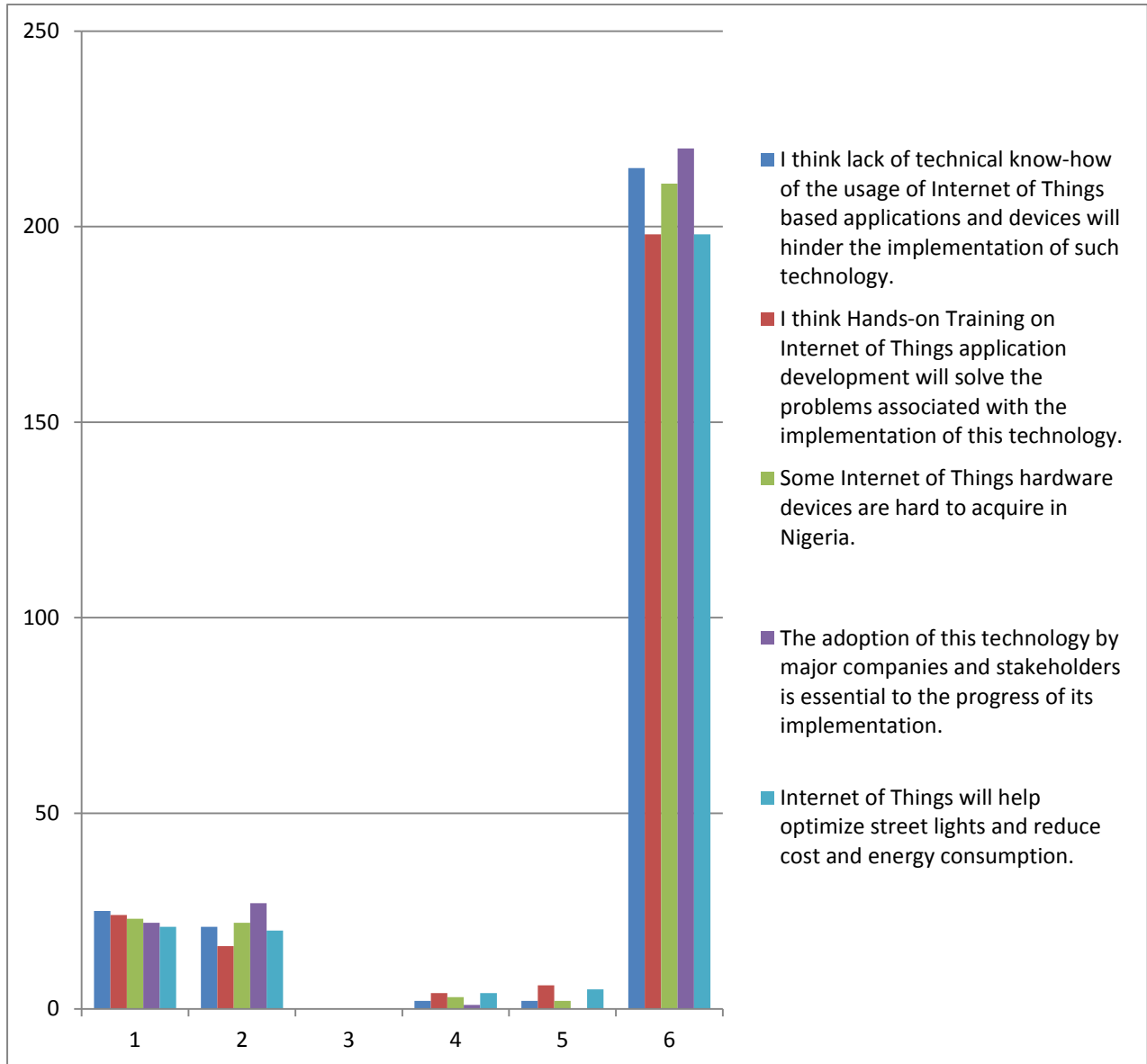


Figure 10: Improving Street light energy utilization by Internet of Things

Figure 10 indicates that the adoption of Internet of Things (IoT) by companies and stakeholders will boost its progress and implementation. While a few believe that training people on the usage of Internet of Things (IoT) application will solve problems associated with its usage. Also some of the respondents are of the belief that hardware devices that are used for Internet of Things (IoT) based street lighting system are hard to acquire.

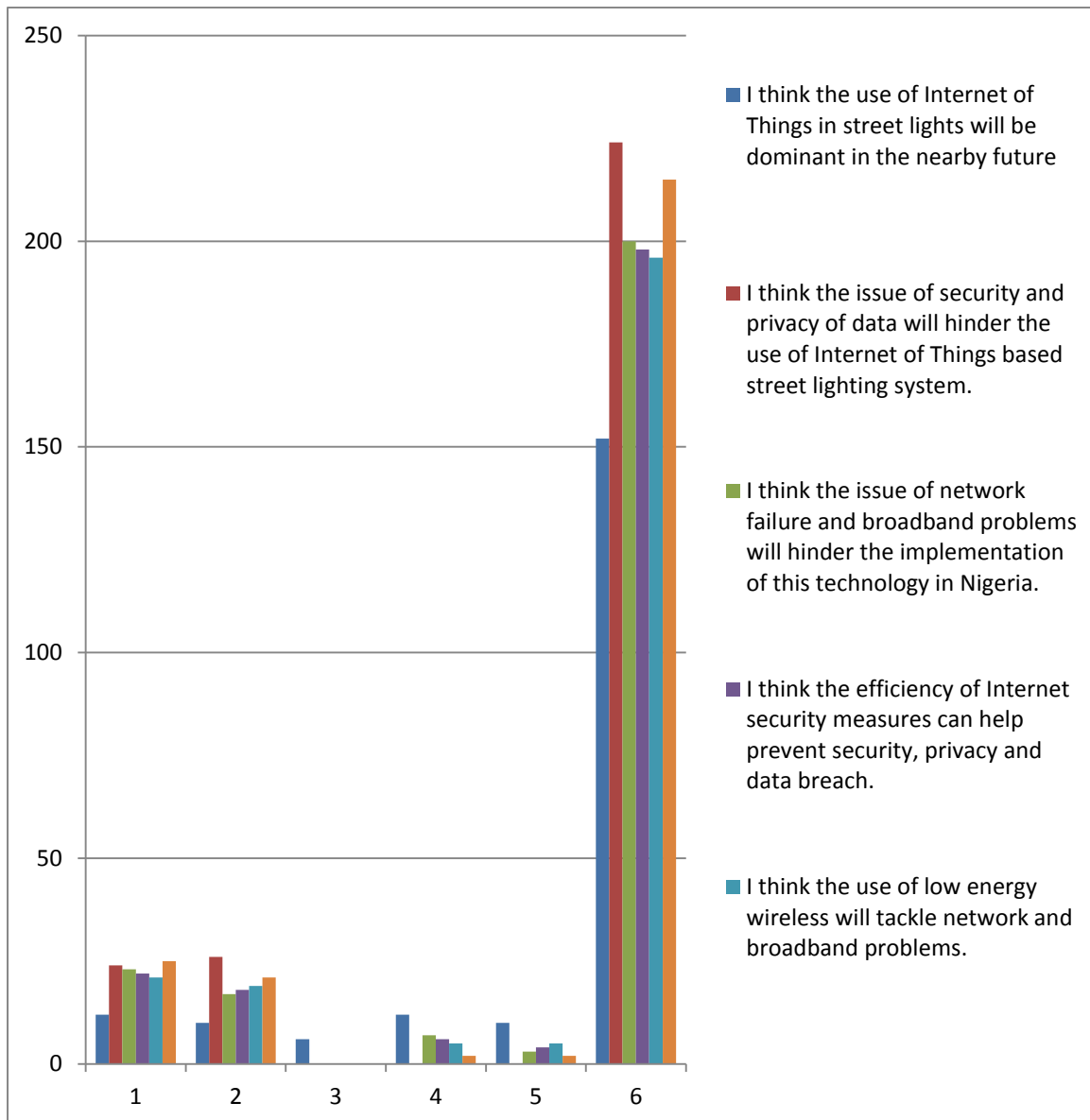


Figure 11: Improving Street light energy utilization by Internet of Things

Figure 11 shows most of the respondents believe that the Government has wasted time and resources relying on current street lighting system, rather than adopting smart street lighting system, despite the energy wastage and high cost. Some of the respondents also believe that some countries are afraid of adopting Internet of Things (IoT) as an ultimate solution to street light optimization. Some respondents also believe that the addition of computational intelligence, network connectivity and storage to street light is the basis of Internet of Things (IoT) based street lighting system implementation.

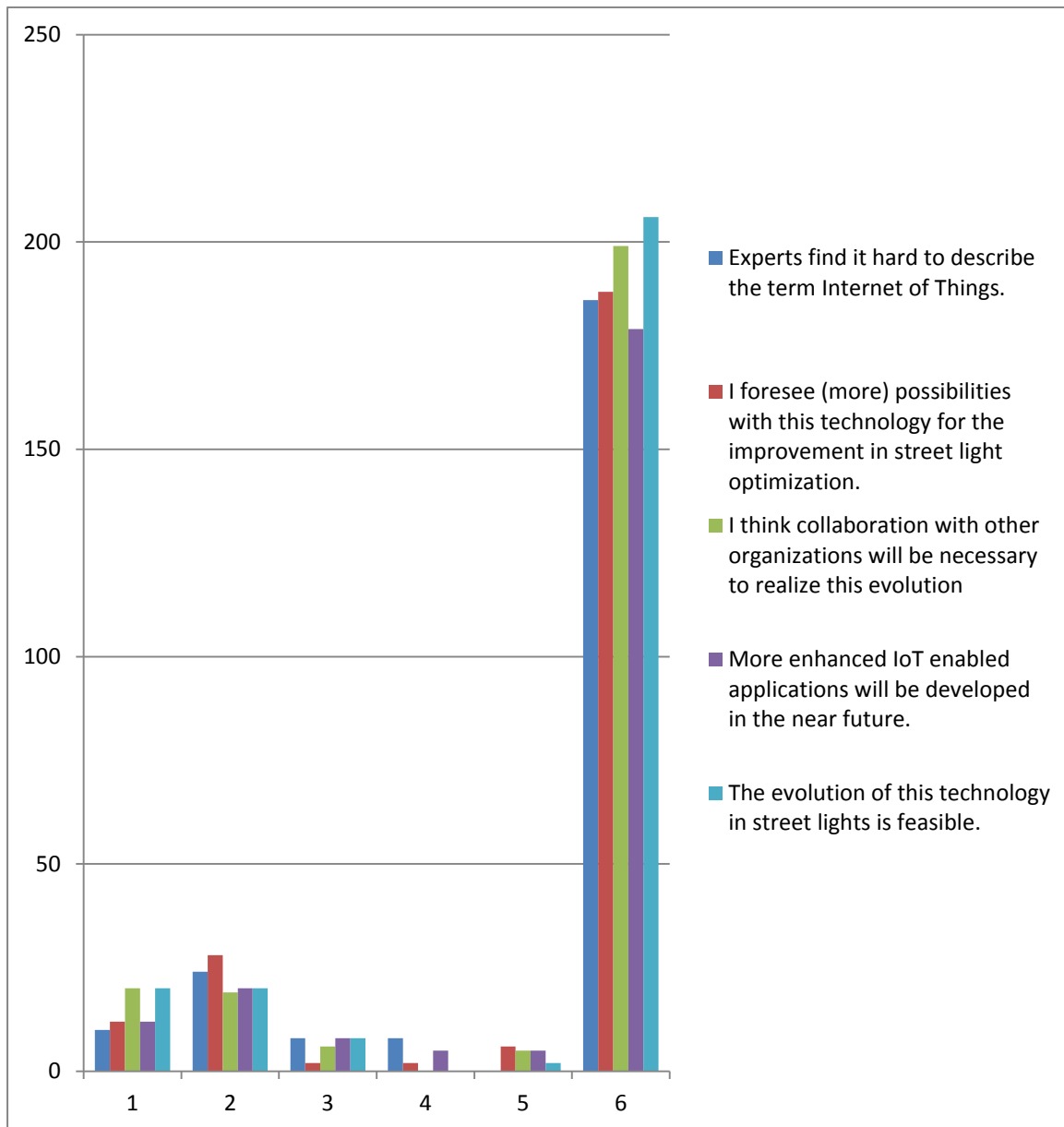


Figure 12: Improving Street light energy utilization by Internet of Things

Figure 12 shows that most people (respondents) have never heard of the term Internet of Things (IoT), while a few of the respondents believe that Internet of Things (IoT) enabled application will be developed in the nearby future. Also shows that the respondents believed experts find it hard to describe the term Internet of Things (IoT).

5. Conclusion

Internet of Things and smart lighting technology promises efficient and effective alternative system of street lighting that is more efficient and effective than the current system. It was

discovered that awareness of the efficacy of smart lighting technology adoption in the power sector is as important as its application and usage.

Analyzed questionnaires based on the Likert ranking scale indicated that even though, stakeholders are less aware of Internet of Things, yet, they are optimistic of its capability in restoring effectiveness and better management of street lights in Nigeria and respondents indicated their willingness to adopt the new technology – though change takes time. Result indicated a unanimous believe that Internet of Things will and can certainly improve renewable energy utilization. The ability of the system to integrate and network vast numbers of small-scale distributed energy generation and storage devices and to precisely manage electrical power demand down to the residential level promises to bring extensive changes to the current system along with splendid benefits, drastic improvement in generation to supply and potential stability in the entire system. The scope of this study focuses on the appraisal of the role of internet of things in street light optimization only, thus it does not cover other lighting systems like the traffic lights, home lighting systems, etc.

Also the findings and data related to this research are limited to Kano state, because the entire research was conducted within Kano metropolis, a rather small segment of the world.

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**ASSESSING THE QUALITY MANAGEMENT PRACTICES (QMP) AFFECTING
BUILDING PROJECTS DELIVERY IN NIGERIA: A LITERATURE REVIEW
APPROACH (2019 – 2023)****Timothy Mwanti Daylop¹ & Joseph K. Makinde²**

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ABSTRACT

The issue of Quality Management Practices (QMP) in the Nigerian construction industry remains integral to the better performances required in delivery of construction projects. This is due to the need to avoid defects, reworks and its attendant effect and cost on the construction organizations and construction professionals undertaken the delivery of projects. As a result, this study undertakes a review of QMP affecting building project delivery in Nigeria between 2019 and 2023. The outcome suggests that the topmost factors affecting the QMP encompass customer focus, process improvement, continuous improvement, conformance, and durability. This study recommended that the implementation phase of the project should include the adoption of effective measures for total quality management, as there should be ongoing evaluation of contractors and their organizations to assess their adherence to quality standards set by regulatory bodies and government agencies. This is necessary to reduce the occurrence of building defects, avoidance of reworks and possible collapse.

Keywords: Building Projects, Literature Review, Nigeria, Quality Management Practices (QMP)

1.0 Introduction

The construction industry is crucial in promoting economic growth in national economies and has been described as a catalyst for development (Ali & Rahmat, 2010). The economic growth is evident via the industry's creation of income or value added (Pheng & Hou, 2019). The construction industry in Nigeria has a substantial influence on the local level. Shittu et al. (2020) assert that the housing sector in Nigeria has a pivotal impact on the nation's socio-economic progress by making significant contributions to infrastructure and jobs. Olatunji et al. (2016), states that the involvement of the construction industry is impeded by several obstacles and complex issues. The sector's deterioration is shown by occurrences of structural failures, the prevalence of deserted construction sites, and the general lack of acceptable standards in finished projects (Zubairu, 2016). The impediments include a variety of challenges, including a lack of coordination, limited availability of resources, unethical behaviours, fluctuations in material costs, project delays, and insufficient management (Ogunmakinde et al., 2019). The operational performance of the construction sector is impeded by several issues, such as a lack of technical and managerial expertise, occurrences

of corruption, and insufficient project planning and control (Ezeokoli et al., 2021). Ekpenyong (2016), states that the construction industry has seen a decrease in project performance over time as a result of substandard workmanship and a lack of emphasis on quality management.

Bayraktar (2020), has underscored the significance of satisfying the client's expectations about cost, quality, and schedule for each construction project. Nevertheless, it is important to acknowledge that Zubairu (2016) has seen a lack of promptness in the implementation of comprehensive quality control procedures within the construction industry in Nigeria. It is crucial to recognize that this problem is not exclusive to Nigeria, as shown by the discoveries made by Longtau et al. (2016). Quality management, as defined by Mohd et al. (2018), is the process of maintaining construction job quality at the required level to achieve customer satisfaction and sustain long-term competitiveness and company survival. The need of quality management in building projects is of utmost relevance (Rotimi, 2020). Therefore, project managers prioritize quality management and quality assurance as they recognise the negative outcomes that result from subpar construction, such as early defects, structural collapses, harm to reputation, and significant costs for repairs (Bittharia& Tiwari, 2021). Mahmood et al. (2010), estimate that the costs for repairing inadequate quality are around 150% more than the original cost. Nevertheless, despite efforts to educate and train construction workers about the need of adhering to quality standards, the problem of substandard delivery persists within the construction industry (Orji et al., 2019). Ekpenyong (2016), has shown a link between the level of implementation of quality management practices and the performance of projects.

Although there have been advancements in project delivery methodologies, it is clear that a considerable proportion of construction projects still have shortcomings in delivering structures of satisfactory quality (Ekpenyong, 2016). An important problem in the Nigerian construction industry is the huge increase in the number of building collapses throughout the country (Abdulkareem and Adeoti, 2010). Defects or malfunctions in integrated facilities might result in substantial cost constraints. Although there are minor flaws, it could be essential to make adjustments, which might cause interruptions to the facility's operations. As a result, there has been a rise in expenditures and a postponement in project schedules. Ekpenyong (2016), states that in the most extreme situations, failures might result in physical injury or even fatalities. In recent decades, the construction industry has received significant criticism over its performance and productivity compared to other sectors. The construction

industry is now undergoing a period of deep self-reflection, mostly due to the growing impact of technological breakthroughs and cultural changes that have occurred since the beginning of the 21st century (Kannan & Tan, 2015).

According to Muhammad (2021), the poor construction of buildings has led to a higher need for maintenance, rehabilitation, and restoration work to ensure the operation and safety of these structures. Therefore, the housing industry in the North-central geopolitical zone is prone to the cited barriers and defects in building. The main factor contributing to these difficulties arises from the absence of proactive measures taken by government institutions responsible for housing provision. However, it seems that the government does not perceive the challenges encountered by the construction industry as noteworthy (Kim and Park, 2013). Consequently, these difficulties have not been sufficiently resolved, highlighting the ongoing need for the adoption of effective quality management practices. Xiao and Proverbs (2003) argue that the construction industry must make progress in product quality (achieving accuracy on the first attempt), delivery efficiency (in terms of quality, cost, and timeliness), and the sustained growth of construction firms (ensuring profitability and competitiveness) in order to improve overall project performance. The stakeholders are faced with the challenge of efficiently implementing projects with exceptional quality within the specified time frame and cost limitations. The primary focus of stakeholders is the lack of understanding about the influence of efficient quality management practices on quality performance (Ekpenyong, 2016).

Quality performance improvement has consistently been a prominent topic in significant studies, such as Sir John Egan's influential 'Rethinking Construction' study (Egan, 1998). In order to attain this improvement in project performance quality, it is important to examine the elements that contribute to subpar performance in terms of quality. It is evident that the implementation of effective quality management techniques by contractors is crucial in reducing issues and their recurrence. In addition to these factors, there is a suggestion, primarily based on anecdotal evidence, that certain elements such as quality assurance practices, quality control practices, and quality management practices also exert a substantial influence on quality performance by shaping the participants' approach to work. Regrettably, the building industry has shown no regard for these considerations, with much of the debate

being unfocused and lacking in substance. This research examines the QMP of construction organizations in Nigeria in response to this requirement.

2.0 Literature Review

2.1 Concept of Quality

The term 'quality' has its origins in the Latin word 'qualis'. Providing a precise definition for this word is difficult since various persons understand it in different ways (Sahney, 2004). Warwood and Roberts (2004) contend that the notion of quality is not new, but has shown substantial advancement in recent years. The definition of the term "quality" is prone to variability. Nevertheless, other viewpoints on this issue have been presented by additional sources (Demirbag, 2006). Edwards Deming, defined quality as a methodical strategy aimed at fulfilling both present and future customer demands (Deming, 1986). In addition, Joseph M. Juran, a renowned authority in the realm of quality management, provided a precise definition of value as "the extent to which a product or service is appropriate for its intended purpose or utilization" (Juran, 1988). In addition, Feigenbaum (1963) is recognized as the originator of the idea of "Total Quality Control." He offered an all-encompassing definition of quality, which includes the combined characteristics of a product and service, embracing aspects such as marketing, engineering, production, and maintenance. These traits are essential for ensuring that the end product or service fulfills the customer's expectations and satisfies their individual criteria.

2.2 Techniques for Measuring Quality

Total Quality Management (TQM) necessitates a perpetual improvement strategy focused on reducing variability. To efficiently facilitate and promote a certain procedure, an organization must use top-notch administrative tools and techniques. It is recommended to start with more basic strategies and procedures, as proposed by Ahaotu (2018), such as the Pareto Diagram, Cause-and-Effect Diagram (Fishbone Diagram), Scatter Chart, Control Chart, and Stratification. The following sections elaborate on these themes.

2.2.1 Scatter Plot

A graph that bears similarity to a pie chart signifies a development that goes beyond the cause and effect diagram. Undoubtedly, the happening of a solitary event might trigger a sequence of future happenings, leading to an accumulative impact. This phenomenon offers useful

insights into the interdependence of factors and variables that may influence a result (Yi, 2022). Nevertheless, there is a lack of clarity in understanding the connection between specific causes and their resulting effects (Ishikawa, 1983). Moreover, it does not provide the precise measure of the impact imposed by any factor. Ozeki and Asaka (1990) define a scatter diagram as a visual representation that shows the connection between two sets of data or the average between two locations. It demonstrates the overall effect of an original event that results in a sequence of future incidents (Ishikawa, 1968). This diagram is essential for categorizing the main important elements that lead to the development of condition traits. It emphasizes the need of focusing efforts on exercising direct control.

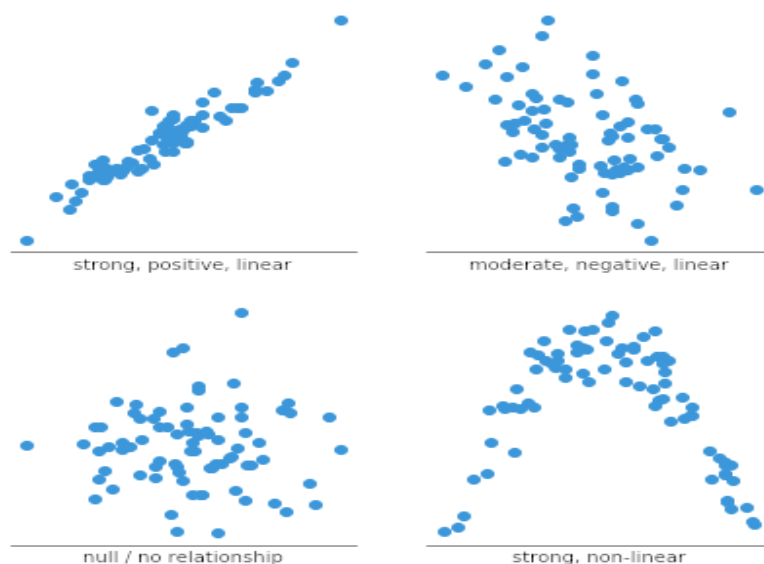


Figure 1: Scatter Diagram

Source: Yi, (2022).

2.2.2 Stratification

When gathering data for a research, it is beneficial to categorise the information based on the kind of material, type of equipment, timing, control, or other relevant categories in order to get a more comprehensive picture of the situation. This facilitates a seamless identification of the underlying causes and difficulties (Ozeki & Asaka, 1990). Moreover, this is applicable in the management of product quality tools, such as check sheets, histograms, and control charts.

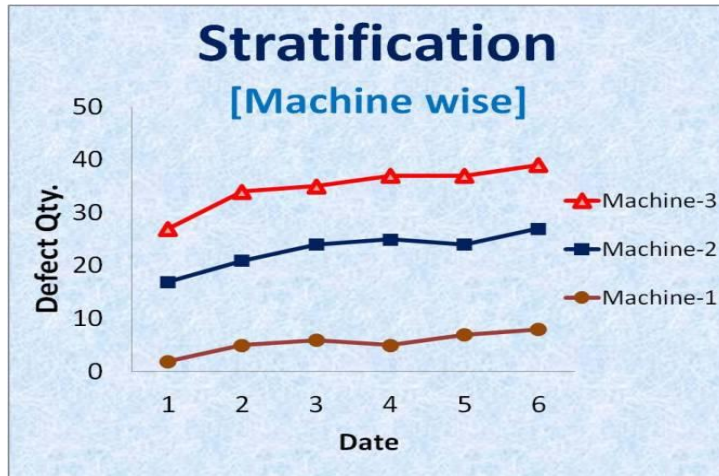


Figure 2: Machine Wise Stratification

Source: techqualitypedia.com/stratification-meaning, (2022).

2.2.3 Cause and Effect Diagrams

Cause-and-effect drawings are visual representations that identify probable reasons for specific challenges related to quality. The term "fishbone diagram" is often used since it depicts the skeletal structure of a fish. The "head" of the fish refers to the problematic aspect, such as a faulty fastening on a garment or bad valves on a tyre. The figure is shown to illustrate the central structure of the angle that connects the "head" to the potential root cause of the issue. These reasons may have been associated with the machinery, measurements, suppliers, personnel, materials, and several other aspects of the production process (Mahto & Kumar, 2008). Each of these potential reasons may have a smaller advantage that specifically solves the associated concerns of each cause. A question that arises in relation to machines may be due to the need of customization, conventional supplies, or issues with delays, for example. Therefore, an issue that workers may face might be attributed to insufficient training, a poorly planned project, or exhaustion. Cause and effect diagrams are often used by quality control teams to identify specific reasons of issues that may be investigated via problem-solving (Yousoff et al., 2004). The development of a cause-and-effect diagram requires the group to provide justification for all potential factors that may contribute to low quality (Khekalei et al., 2010).



Figure 3: Fishbone Diagram

Source: Trout, (2022).

2.2.4 Control Chart

A control chart is mostly used to evaluate the consistency of a process (Ozeki & Asaka, 1990), and it is a two-dimensional graphic. For instance, the horizontal part of the shaft gradually develops an estimate over time, while the vertical part of the shaft establishes the fundamental principles of condition quality (Ahaotu, 2018). The chart consists of three parallel lines: the middle line represents the average advantage of the quality features, while the other two lines represent the Upper Control Limit (UCL) and the Lower Control Limit (LCL). The measures are estimated throughout time, and if the principles of condition features fall inside two boundaries, it is primarily known that the process is determined. Alternatively, if a small number of values exceed the control limits, it suggests an imminent issue. Consequently, a thorough investigation is required to identify the early stages of the problem and eliminate the root cause in order to prevent its recurrence (Montgomery, 1991). Therefore, these seven controls for product quality are very efficient and, as Ishikawa asserts, may effectively address the many issues faced by various firms (Galgano, 1994). Nevertheless, it is essential to document the repercussions of these technologies while implementing process enhancements.

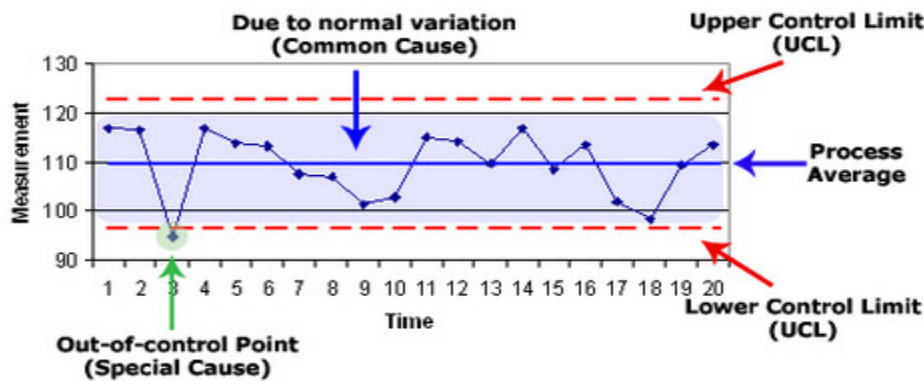


Figure 4: Control Chart

Source: Foley, (2021).

2.2.5 Pareto Analysis

A Pareto analysis is a technique used to identify quality issues based on their level of importance. The justification for using Pareto thinking is based on the understanding that some types of difficulties are essential, whereas many potential alternatives are not crucial (Ahaotu, 2018). The strategy was selected based on the principles established by Vilfredo Pareto, an Italian statistician from the 19th century, who proposed that a small fraction of individuals own the majority of resources (Yi, 2022). This concept is often referred to as the 80-20 rule and has been extended to several domains. In the field of quality management, Pareto's law is based on the understanding that the majority of quality issues arise from several sources, and the objective is to identify and categorize these causes.

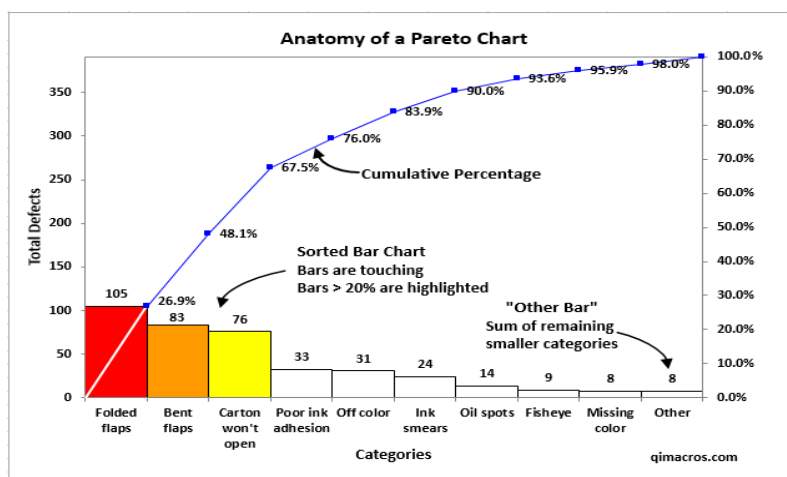


Figure 5: Pareto Distribution Example

Source: qimacros.com/pareto-chart-excel/pareto-principle, (2022).

2.4 Review of Related Studies

AUTH OR/YE AR	TITLE	MAJOR FINDINGS	PRACTICAL IMPLICATION	LIMITAT ION
Unegbu et al. (2023)	An investigation of the impact of quality and cost management on project performance in the construction industry in Nigeria	This finding aligned with the confirmatory factor analysis results, which indicated a significant impact of the factors influencing quality and cost management implementation. The structural equation model (SEM) analysis, used to assess the impact of quality and cost management on construction project performance, demonstrated a high level of impact, with the strongest correlation observed between project cost monitoring and control and construction phase performance	Explains urgent measures are needed from industry stakeholders to address the factors hindering the effective implementation of quality and cost management, aiming to enhance project performance	-
Ozor & Chikwe (2023)	Project Communication Management and Project Quality of Construction	The findings indicated a significant positive relationship between project communication management practices and	Explains the construction firm should prioritize effective communication	Restricted to South – South Nigeria

	Firms in South - South Nigeria	- project quality and management to enhance concludes that improving project quality, leading project communication to increased stakeholder management can satisfaction and project positively impact the durability. project quality of construction firms in South-South Nigeria	
Charles (2023)	Application of Total quality management and building maintenance operations in building construction in Abuja Nigeria	The findings of Review/analysis used to improve performance, Well-defined roles and responsibilities of project participants, Clearly defined goals and objectives, Incentives for good performance.	Exposes the need for Reduced number of firms to ensure all site personal are adequately respondent qualified to delivery on s the tasks assigned to them, materials used on site should be properly certified before usage and all stakeholders on a project should possess adequate information and full knowledge of such project before work commences
Osegbo et al. (2022)	Assessment of quality management practices of ministry of housing registered building construction	The result revealed that the quality management practice of Building construction companies in the study area do not conform to the international standard but they are more interested in getting work done just to	It posits the need for an Limited to establishment of a clear Anambra and well-defined QM State system duly communicated from management level to site operatives such as ISO 9001 QMS, they should also train their staff

	companies in receive payment. Also, regularly. Government Nigeria a case lack/inadequate should establish Quality study of Anambra employees' education and control units. State training; lack of top management commitment/support emerged the most challenging to QM practice.	
Rotimi (2022)	Assessment of Quality Management Practices in Construction Firms in Nigeria	The study revealed among other that Total quality management (TQM) is not common practice. The purpose of quality management is mainly for fulfilling their obligation under the construction contract rather than increase customer satisfaction as emphasised in the philosophy of TQM
Egwuna tum et al. (2021)	Total quality management (TQM) implementation in the Nigerian construction industry	The study revealed that major practice of TQM principles with respect to structural failure rate are purchasing: ensuring the procurement of materials of the specified quality standard, ensuring the use of a quality improvement construction process of the
		The study exposed the need for small scale construction companies to regularly share information in order to be up to date with the recent quality information
		This will be useful in guiding construction firms, other industry's key stakeholders and regulatory agencies in bringing about a sustainable quality management system for improve profit and value maximization and

		organization, site avoiding incessant management structural failure responsibility: this entails ensuring quality supervision by the project management leadership and monitoring and control of quality during the construction to guarantee firm observance quality standards.	
Mohamed (2021)	Impact of Project Quality Management on the Performance of Residential Estates in North-Central Nigeria	The results show coefficient of determination (R Square) of 0.944, 0.93, 0.982 and 0.846 for sustainable performance, quality cost, quality management practice and sustainable quality management model latent variables respectively for residential estates in North-Central Nigeria, viz: This means that sustainable performance of residential estates in North-Central Nigeria moderately explain 94.4% effect on all variables. Quality cost together explains 93.12% effect of all variables.	It posits the need for proper quality to the conformity analysis North-Central region of Nigeria which should be periodically carried out for sustainable performance of residential estates.

			Quality management practices explains 93.1% variance effect, while Sustainable quality management model factor explains 84.6% variance effect	
Adeosun et al. (2020)	Assessment of Quality Management Practices and Building Collapse in Osogbo, Osun State, Nigeria	of The study revealed that handling of the construction process by contractors and other unqualified and quacks, possession of approved drawing without compliance and usage of substandard building materials were the major causes of building collapse.	Exposes the need for constant evaluation of to State players to determine the level of compliance to quality standards as prescribed by the regulatory bodies to curb the incidences of building collapse.	Restrained to Osun State
Osho (2019)	Quality Management Practices of Contracting Firms in Building Project Delivery	The study revealed that quality control procedure is the top ranked quality management system adopted by contracting firms in building project delivery. The top ranked barrier and benefit of	Provides research information on the many benefits and barriers to QMS implementation by contracting firms in building project in Lagos state, in a bid to increase the level of	Limited to the confines of Lagos State

quality management awareness of QMS and practices of contracting its resultant effect on firms are shortage of construction project skilled workers and outcome. improvement in company reputation.

Dorcas et al., (2019) Most critical factors responsible for poor project quality performance in building construction industry (A case study of three major cities in Nigeria) The most severe factors affecting project quality in Nigeria construction industries are: project quality construction mistakes, use of inexperienced labours, poor checking and inspection, Poor motivation (incentives) and others. There is more awareness as to the most critical factors responsible for major state project quality in Nigeria performance in building construction industry

Source: Authors' Literature Review, (2023)

3.0 Research Methodology

The systematic approach offered by research methodology allows readers to analyze the study topic in relation to the defined research objectives (Leedy, 2000, p. 246). This research used a modest application of meta-analysis and an interpretivist epistemology approach to conduct a comprehensive systematic assessment of the TQM studies in Nigeria, specifically examining the factors influencing its adoption in the country. Searches for TQM research in

Nigeria were carried out with databases such as Google Scholar and Semantic Scholar. Citation tracking was used to ensure that a significant number of the research studies being analyzed were considered. This research provides a thorough examination of the elements that influence the application of TQM in the building industry of Nigeria. This review encompasses a comprehensive analysis that utilizes qualitative, quantitative, and mixed research approaches. It draws from pertinent and previous studies in the area conducted from 2018 to 2023. The literature review process involves the use of relevant, appropriate, and interrelated scholarly publications to answer the research objectives of the current study (Muhammed et al., 2022). The study primarily uses Tranfield et al. (2003) systematic review methodology to highlight the challenges linked to the implementation of TQM. A systematic review has the capacity to enlighten both practice and scholarship on the deficiencies present in the existing research. A systematic review may assist practitioners in making informed judgments on issue management by providing reliable knowledge from a diverse range of outcomes. A systematic review aids scholars in comprehending the dependability and meticulousness of the research methodology used for the given topic, and acts as a catalyst for generating fresh research inquiries. The systematic review showcases its depth in two aspects: firstly, by evaluating the calibre of the research evidence derived from prior (peer-reviewed) studies, and secondly, by subsequently pinpointing novel and captivating study topics that peer researchers may explore as separate investigations. Briner & Denyer (2012) believe that a systematic literature review should include several key characteristics. Firstly, it must be organized in a manner that directly answers the review questions. Secondly, it should be openly stated and transparent in its approach. Thirdly, it should be repeatable, meaning that the review process can be replicated by others. Additionally, it should be updatable, allowing for the inclusion of new information as it becomes available. Lastly, it should be synthesized, meaning that it provides a concise summary of the evidence relevant to the review issue. The systematic review followed the approaches provided by Briner & Denyer (2012) and Tranfield et al. (2012). This was comprised of. Identify the research issue, explore the study, choose and assess the studies, analyse and integrate the data from the research, and then communicate the review conclusions.

4.0 Discussions

4.1 Customer Focus

The QMP concept aims to achieve complete customer satisfaction by maintaining a pervasive customer focus across the whole system. The objective of the building business is to provide facilities that satisfy the requirements of their customer (client) (Ozor & Chikwe, 2023). Total QMP is a managerial ideology that efficiently identifies and addresses client requirements by establishing the necessary structure, atmosphere, and ethos to fulfill those demands while minimizing expenses (Unegbu et al., 2023). By using stringent quality control measures at every phase of the building process, the occurrence of expensive rework and other associated expenses may be minimized. This approach ultimately ensures that the finished goods meet the expectations of the end customer (Mohammed, 2021). By definition, these consumers might be either internal or external. The external customer refers to the individual or organization that ultimately uses the items or services provided. An internal customer, in contrast, refers to a secondary process or department inside the company that relies on the output of the first. Designers see goods as plans and specifications, whereas the consumers consist of the owner and the contractor who are accountable for the building process (Adesoun et al., 2020). The contractor's objective is to provide the finished facility, which will be used by the client as the end user. Additionally, the building organization has internal consumers that acquire goods and information from various groups inside its organization (Rotimi, 2022). Meeting the demands of internal consumers is a crucial aspect of delivering a high-quality product to the ultimate external customer (Egwunatum et al., 2021). In order for a building organization to achieve optimal efficiency, it is essential that all components within the organization function cohesively. Each component, every operation, and every individual inside a construction firm has an impact on and is reciprocally influenced by others. Each stakeholder involved in a process assumes one of three roles: supplier, processor, or customer. These three duties are performed at every stage of the building process as illustrated by Figure 1. The designer acts as a client to the owner. The designer creates the design and provides the contractor with blueprints and specifications. The contractor serves as the client of the designer, using the designer's plan and requirements to execute the building process and deliver the finished facility to the owner. The owner provides the specifications to the designer, obtains the facility from the contractor, and assumes responsibility for the operation of the facilities (Unegbu et al., 2023). This clearly demonstrates that construction is a sequential procedure, and that QMP principles, which

have been successfully implemented in other industries, can potentially be applied to the construction sector.

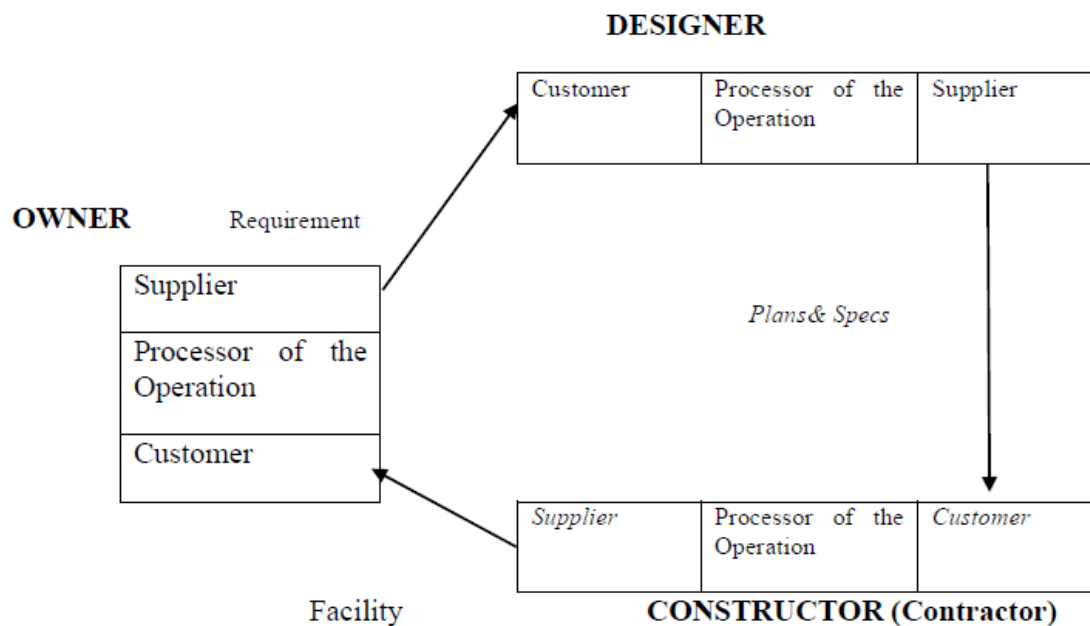


Figure 1: Juran's Triple Concept applied to Construction

Source:CII Publication 10-3 in Jozef, G. (2007) , Pg 166.

4.2 Process Improvement

A process refers to a systematic approach used to accomplish tasks and fulfill the requirements of both internal and external consumers. It encompasses the essential processes, policies, and activities (Osho, 2019). According to the QMP principle, if the process is accurate and precise, the final result (product) will also be of high quality. Therefore, it is essential for the organization to enhance the process in order to enhance the final product or service (Dorcas et al., 2019). Three distinct methodologies have surfaced for enhancing the efficiency or efficacy of a process. Continuous improvement is a perpetual method used to achieve gradual advancements. Periodic use of benchmarking and occasional implementation of reengineering may lead to significant breakthroughs (Osegbo et al., 2022). By emphasizing process optimization via meticulous measurement and analysis, it is possible to enhance a process by modifying the five key elements known as the "five M's": man, machine, method, and measurement (Rotimi, 2022). The primary focus of process improvement is on measuring, controlling, and understanding variance in order to achieve improvement. This analysis is referred to as statistical process control or statistical analysis. According to

Unegbu et al. (2023), it serves as the focal point for enhancing processes. The purpose of measuring the variation in a process is to get knowledge on how to effectively manage and enhance the process by considering variance as a means of improvement.

4.3 Continuous Improvements

TQM stands out from other management theories because it provides a particular and systematic approach to achieving continual improvement, a goal shared by many theories. The technique has nine sequential stages, as outlined by Ozor and Chikwe (2023): Determine the procedure; Assemble a diverse team of experts from several fields to analyze the process and provide improvements; Specify the specific domains or fields where more data is required; Gather information on the procedure; Perform a thorough analysis of the gathered data and engage in a creative process to generate ideas for improvement. Identify suggestions and strategies for putting into action; Execute the suggested proposal to validate its efficacy, then revisit step five to reevaluate the data and generate ideas for further enhancement. The nine-step cycle prioritizes: concentrating on progress, measuring the process, brainstorming for improvement, and verifying and re-measuring. The four aspects mentioned are shown in Deming's Plan-Do-Check-Action (PDCA) diagram, as seen in Figure 2. The PDCA diagram emphasizes the elimination of the underlying source of issues and the ongoing establishment and modification of new standards or objectives (Deming, 1986). Within the framework of TQM in the construction sector serves two distinct functions:

- i. The objective is to uphold and enhance existing techniques and procedures by implementing process control.
- ii. The aim is to lead efforts towards achieving significant technical advancements in building processes via innovation.

The enhancement of the process is attained by the use of process improvement and control measures. Within any building organization, there are fundamental procedures via which all tasks are completed. Nevertheless, there are many components involved in the building process. By using flow diagrams, it is possible to dissect any process into distinct steps (Adeosun et al., 2020). In each level, there occurs a transformation of input into output, and the techniques and processes that govern this transformation (i.e. the construction procedures) may be continuously enhanced to more effectively meet the customer's needs in the subsequent stage (Charles, 2023). Throughout each phase, it is important for the staff to maintain close communication with both their supplier and client in order to enhance the

efficiency of the work process for that particular stage (Egwunatum et al., 2021). Each employee must acknowledge their role in the process, as well as their corresponding supplier and consumer.

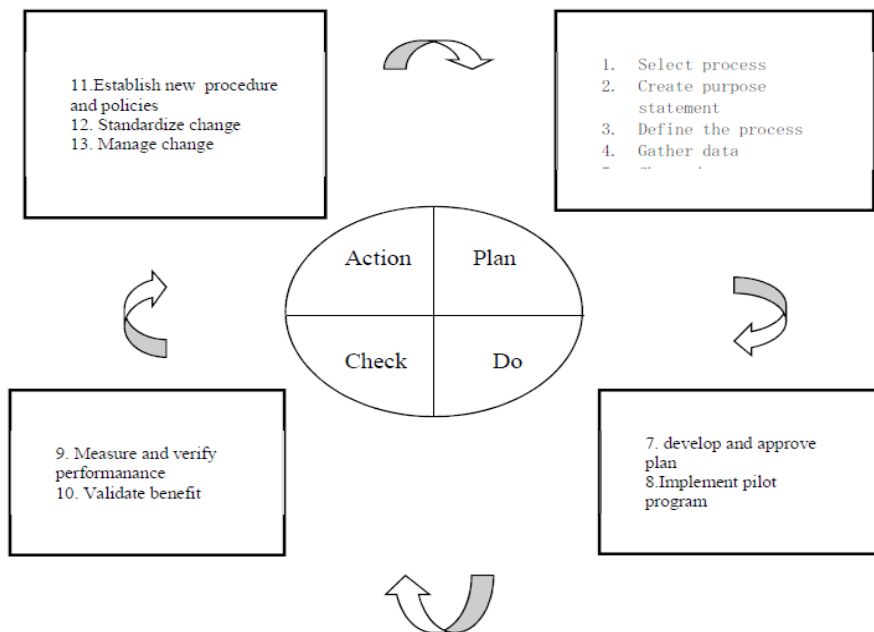


Figure 2: Deming's Plan-Do-Check-Action (PDCA) Diagram

Source: (Deming, 1986) in Syed, Salman and Mauricio (2001) Pg 12.

4.4 Conformance

Conformance is an essential aspect of quality and is necessary for the effectiveness of comprehensive quality management techniques (Osho, 2019). The term "conformance" refers to the extent to which product designs and operational characteristics align with defined standards, whether they are internal or external, in order to achieve customer satisfaction (Mohammed, 2021). One current problem is that a certain percentage of these items have not met the required criteria, meaning they have flaws. This is seen as a significant occurrence in the way the products are managed (Rotimi, 2022). Reliability and compliance are intricately linked in the methodologies of comprehensive quality management, which aim to achieve optimal quality and enhance performance efficiency. Once service quality is achieved, the genuine customer happiness is likely to be reflected (Adeosun et al., 2020).

4.5 Durability

Within the framework of comprehensive quality management methods, durability refers to the extent to which a product can withstand the test of time. It encompasses both economic and technical aspects, taking into account the difficulties involved with meeting consumer expectations and demands (Charles, 2022). Per Egwunatum et al. (2021), durability refers to the extent to which a product deteriorates over time. For example, after a prolonged period of usage, the filament in a fluorescent bulb may get burnt and repairing it becomes impractical. Consequently, the fluorescent bulb will need to be replaced. Hence, when the repair is possible, comprehending durability becomes very challenging since the lifespan of the product varies with a specific alteration in economic circumstances (Ungebu et al., 2023). According to Dorcas et al. (2019), durability, in accordance with overall quality management principles, refers to the length of time a product may be used by a client before it begins to malfunction or break down. Customers have many problems, difficulties, and options when their items do not meet the anticipated cost, resulting in customer discontent. Product longevity resulting from effective implementation of total quality management or improvement, where products meet high quality and value expectations, leads to customer satisfaction. This represents the economic and technical aspect of durability as a component of total quality management practice (Ozor & Chikwe, 2023). When considering quality, durability has two important meanings, since it is strongly linked to the dependability of a component. If a product or service does not meet quality standards, it may be discarded earlier than products that meet reliable standards. This is because repairing the product could be more cost-effective, and purchasing a product that meets customer satisfaction would be more desirable. However, it is important to interpret desirability with caution. Nevertheless, it is possible to propose technological enhancements to ensure long-term service and positively impact customer happiness. Under such circumstances, the implementation of environmental alteration might be used to augment the overall quality of durability (Osegbo et al., 2022).

5.0 Conclusion and Recommendations

This study examines the QMP factors that impact the delivery of building projects in Nigeria. It concludes that the most significant factors affecting the quality of building projects delivery include customer focus, process improvement, continuous improvement, conformance, and durability. These factors are essential for ensuring high-quality outcomes

in construction projects. Consequently, the following suggestions may be inferred from this conclusion:

1. It is suggested that the implementation phase of the project should include the adoption of effective measures for total quality management. Additionally, there should be ongoing evaluation of contractors and their organizations to assess their adherence to quality standards set by regulatory bodies and government agencies. This is necessary to reduce the occurrence of building collapses.
2. Developing effective quality management practices necessitates taking into account various factors for successful implementation, including obtaining a commitment from senior management, ensuring adequate resources to integrate multiple approaches, and providing appropriate training to enhance quality, which can yield additional benefits in terms of policy implications from a management standpoint.
3. Companies must ensure that all personnel on site are sufficiently qualified to carry out their assigned tasks, and that materials used on site are properly certified before being used. Additionally, all stakeholders involved in a project should possess sufficient information and complete knowledge of the project before work begins.
4. Regulatory organizations should promptly revoke the license of any construction company that fails to appropriately adopt QMP in the construction process.

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THE EFFECTS OF SOIL EROSION ON AGRICULTURAL FARMLAND IN BIRSHI/MIRRI WARDS OF BAUCHI LOCAL GOVERNMENT AREA OF BAUCHI STATE, NIGERIA.

BY

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ABSTRACT

A survey was conducted in Birshi/Mirri words in Bauchi local Government Area, Bauchi State. A survey was conducted or done in order to: determine the effect of erosion on agricultural farmland faced by the farmers in Birshi/Mirri wards, identify the practices that cause erosion and also assess farmers' perception in relation to the effect of erosion on the agricultural potentials and performance of the communities. The data was collected in form of oral interview where by structured questionnaires were administered to 65 individuals at random among farmers in the Wards of the Local Government Area. The causes of soil erosion by nature of the soil as revealed by the farmers was 26%, lack of adequate drainage 17% was also the cause of soil erosion. High percent (42%) farmers practicing multiple cropping as controlled practices, the major effects of soil erosion encountered are reduction in crop yield on their farms (23%), 5 farmers (10%) encountered loss of topsoil, 7(11%) of the farmers had problem with reduction in soil nutrient, 17% and decreased of farm sizes 8% due to heavy rainfall. It was recommended that farmers should have a change of attitude in order to avoid the possible causes of erosion on their farmland. This may be achieved by planting more trees, avoiding deforestation, and overgrazing as well as encouraging the use of those sustainable agricultural practices.

Keywords: *Erosion, Causes, Effects, farmland.*

1.0 INTRODUCTION

1.1 Background of the Study

Erosion is recognized as one of the world's most serious environmental problems (Pimentel *et al.*, 2005, Shiferaw and Holden, 2009). Globally, about 80% of the current degradation of agricultural land is caused by soil erosion (Angima *et al.*, 2003). Erosion by water, at a global scale, is the main soil degradation process in agricultural areas (Bewket and Sterk, 2002). It

generates strong environmental impacts and major economic losses from decreased agricultural production and from off-site effects on infrastructure and water quality by sedimentation processes (Zinabue *et al.*, 2002; Daba, 2003; Haregeweynet *et al.*, 2005; Amsalu *et al.*, 2007).

Erosion creates severe limitations to sustainable agricultural land use, as it reduces on-farm soil productivity and causes food insecurity (Tadesse, 2001; Sonneveld, 2002; Beshah, 2003, Moges and Holden, 2006, Bewket, 2007). In most developing countries human activity triggers these losses (Mohammad *et al.*, 2001, Belyaev *et al.*, 2004, Bewket and Sterk, 2005, Hurni *et al.*, 2005). This is associated with rapid population growth, inadequate attention to the basic natural resources (soils, water and vegetation), and the need to maximize production to meet the needs of the growing population (Shiferaw and Holden, 2009, 2000, Bewket, 2002, Feoli *et al.*, 2002). This situation is more serious in poor developing countries where subsistence production predominates. The average farmer who cultivates one hectare of food crops and keeps some livestock, is nowadays dependent on natural conditions and cannot tolerate further deterioration of soil productivity (Sonneveld and Keyzer, 2003). Increasing population, intense land cultivation, uncontrolled grazing, and deforestation often lead to, or exacerbate, soil erosion (Tadesse, 2001 and Bewket, 2002). These factors undermine agricultural productivity and frustrate economic development efforts, especially in developing countries where there is heavy land dependence (Shiferaw and Holden, 2000) in low external-input farming systems.

1.2 Statement of the Problem

Erosion is considered a major agricultural production problem in Bauchi Local Government area and it is also main source of environmental deterioration (Mustapha, 2007) this result as the expansion of land use conversion is based on the conversion of exiting forest land into cultivation land and grazing land (Chamadaet *et al.*, 2017). It creates negative impacts on agricultural production, infrastructure and water quality (Vrieling, 2006). Erosion is also the natural phenomenon (geological process) which is caused by natural force; it can be more accelerated when the process is influenced by human activities (human-induced erosion). It is considered that the accelerated erosion is a serious global problem and widely recognized (de Graaf, 2006). With the accelerated erosion, it can affect agronomic/biomass productivity (on-site effect) and flooding, sedimentation of reservoirs, siltation of agriculture field and

decrease of water quality downstream (off-site effects). The two important agents of erosion are wind and water (Hudson, 2006).

The study area is located in Bauchi Local Government Area, This area is an intensive agricultural area therein in agricultural system has been taking place. With the increasing population, the cultivation in the mountainous area has been taking place. The primary forest is replaced by the farming of maize, Bean, groundnut, soybeans, rice, and sorghum. The removal of natural forest and vegetation cover in steep slope and followed by improper land use practices have led to the various land degradation problems in the area. Each year during the rainy season a lot of topsoil is eroded and the agricultural lands are affected. On the other hand; the eroded soil and sediments which are transported by the surface runoff affect the downstream cultivation land.

1.3 Objective of the Study

The objectives of the studies are to:

- i. Identify the practices that cause erosion in the study area.
- ii. Discuss the perception of the people in relations to the effect of erosion on the agricultural potentials and performance of the communities in Bauchi state.

1.4 Significance of the Study

The most efficient method of soil erosion will be of greater benefit to people of Bauchi Local Government area which anticipate in unhealthy activities that lead to erosion in the area. It will minimize loss of farmland and become productive. The farmers will surely have increased productivity through increase in hectares of crop production. Such information becomes importance for government and public or policy implementer to plan how to make method process know to the farmer. It will enlighten the general public on the ways erosion can be control/reduced in the study area.

1.5 Scope of the Study

The research study is restricted to farmers in only parts of Bauchi Local Government Area of Bauchi state. The communities include: bayara, yalwa, birshi, rafin-zurfi, and doka community. Reasons why the research is restricted to those community is because been

studying from that place it will be easier to collect data in addition to the limitation of time and financial implications will not permit the researchers to study beyond those places.

2.0 LITERATURE REVIEW

The review on (www.merriam-webster.com) erode is the wear away by action of water, wind, or glacial ice flooding eroded the hillside. And also erosion is the action of surface processes (such as water flow or wind) that remove soil, rock or dissolved material earth crust, from one location on earth to another place where is been deposit. (www.wikipedia.org).

This chapter presents the literature review, and is organized under the following sub-headings:

2.1 Effects of Soil Erosion/ Causes

2.2 Process of Erosion

2.3 Sheet Erosion

2.4 Rill Erosion

2.5 Gully Erosion

2.6 Splash Erosion

2.7 Wind Erosion

2.8 Consequences of Soil Erosion

2.9 Control measures of Erosion

2.1 Effects of Soil Erosion/ Causes

Soil erosion has been identified as a serious environment problem with a multiplicity of social and economic consequences. Soil erosion is a disastrous form Soil environment degradation whose effects are multi- dimensional. Accord to (Michael Pidiwirmy, 2007), past erosion has an effect on soil erodibility for a number of reasons; many exposed subsurface soils on eroded site tend to be more erodible than the original soil, because of their poorer structure and lower organic matter. The lower nutrient levels often associated with subsoil contribute to lower crop yield and generally poorer crop cover which in turn provides less crop protection for the soil. He further expatiate by saying that the implications of soil erosion extend beyond the removal of valuable topsoil, crop emergence, growth and yield are

directly affected through the loss of natural nutrient and applied fertilizers with the soil. Sediment can be deposited on down slope properties and can contribute to road damage. (Michael Pidwirny, 2007) has explicitly stated some of the effects to include loss of properties both home and farm crops, loss in finances and impediment to Urbanization. It should be emphasized that the totality of these negative consequences contributes negatively to production. In addition, damage to vital urban infrastructure such as roads and communication links include adverse effects on sources of water supply for domestic use. According to (Aziegbe, 2004) one of the major effects of soil erosion in our environment is the development of dip-pits. The causes of soil erosion have been intensively discussed during the past 40 years. Soil erosion is a natural erosion process that is enhanced by human activity and occurs in all Landscapes and under different land uses. Beside the influence of human activities, soil erosion processes are also caused by morphometric characteristics of the land surface, the erosive force of rainfall and the erodibility of soil and soil surface. (Toy *et al.*, 2002) gave detailed definition of soil erosion features and processes such as sheet erosion and inter rill erosion, rill erosion, as well as ephemeral and permanent gully erosion. They also describe the influence of changing land use on stream channel erosion. Defines sheet flood, sheet- wash and sheet flow in terms of hydrologic and geomorphic based classification system;

- Sheet flood is unconfined flood water moving down hill.
- Sheet flow is a high- frequency, low magnitude overland flow.
- Sheet wash is superseded by the more meaningful term, rain- wash, which is defined as the washing action of rain on slopes.

The cause and processes of soil erosion are connected as it effects the environment. Intensity of soil erosion is mainly influenced by three factors;

- (1) Erosivity of water
- (2) Erodibility of soil
- (3) Human activities.

Physical aspects of erosivity forces of water are independent of the locally prevailing climate conditions. In reality, different climatic condition reveals deferent erosivity forces of rainfall.

(Van Dijk *et al.*, 2002) critically review published studies of rainfall intensities and kinetic energy in order to derive a generally predictive exponential equation. Next to erosivity by rainfall drops (splash effects) forces by surface runoff (overland flow) are part of the erosivity. Saturated overland flow and surface runoff occur both in tropical semi-arid and semi-humid landscapes. The erodibility of soil has not been rigorously defined (bryan, 2000) highlights the importance of the inherent resistance of soil to erosion process. Result of his research show that many components of erosion response, such as threshold hydraulic conditions for rill erosion, rill network configuration and hill slope sediment delivery, are strongly affected by spatially variable and temporally dynamic soil properties (Bryan, 2000 and Veihe, 2002) examines the spatial variable of erodibility of soil types based on a case study in Ghana. The estimation of factor from soil type can in general be problematic because soil classifications are often not based on parameters reflecting erodibility. Erodibility of tropical soil is highly dependent on grain size distribution, clay content and organic carbon content, which influence the stability of soil aggregates. (Lebissonais, 1996) identifies four main mechanisms by which soil aggravates break down slaking, differential swelling, raindrop impact and physio-chemical dispersion caused by osmotic stress. (Barthes and Roose, 2000) analyze topsoil aggregate stability and compared these results to susceptibility to erosion. (Shiferaw and Holden, 2009) investigate the resistance of dry soil aggregate against rain drops. (Valniset *al.*, 2005) correlates inter- rill erosion to aggregate instability, rainfall intensity and slope gradient.

2.2 PROCESS OF EROSION

As we define soil erosion as the detachment of soil particle and movement of the transportation of soil to deposited from one place to another. So the process includes:

a. Detachment

Is the tearing loose of soil aggregation or particle of transportable sized from their mooring the soil mass.

b. Transportation

Rainfall land runoff energy result in soil erosion detachment and the energy transport by the agent of erosion show how the energy of the soil particle ability of it to be transport and deposited somewhere.

c. Deposition

Soil deposition are natural force move weathered rock and soil from one place to another by gravitational, running water, glaciers, wave and wind all can caused erosion deposition .

2.3 Sheet Erosion

Is removal of fairly uniform layer of soil for the land surface by runoff water and other agents (Meena *et al.*, 2017). This type of erosion is mostly dangerous for our agricultural land as it carries away the humus top soil. It often goes on unnoticed due to gradual, constant and uniform action. It renders the soil infertile and its disastrous influence lies in fact that it is not easily perceptible by the farmer. It may finally result in a complete removal of arable part of top soil. Though this action of sheet erosion, the topsoil is gradually swept clear of its finer element and plant nutrient, and only coarse, infertile materials are left behind (Pimentel *et al.*, 2005 and chude, 2005) opined that sheet erosion occurs is a phenomenon whereby a large area of surface or mere surface water. Sheet erosion occurs nationwide, but it is last perceived because of it deceitful slow progress.

2.4 Rill Erosion:

This is an erosion process in which numerous small channels of only several centimeters in depth are formed. (Kinnell, 2020). It occurs mainly on recently cultivated areas after a rain event. Rill erosion occurs when soil is removed by water from little streamlets that run through land with poor surface draining. Rills can often be found in between crop rows. Although its effects can be easily removed by tillage, it is the most often overlooked and if it is not filled up, it could develop to gully erosion. Farmers can easily handle it (Asadi *et al.*, 2007).

2.5 Gully Erosion:

This is an erosion process whereby water accumulates in narrow channels or rills or crevices and, over short periods, removes the soil from this channel to considerable depths ranging from 30 to 60 centimeters to as much as 23 to 30 meters or more. Gully erosion unlike sheet erosions is more obvious as it makes a remarkable impression on the surface of the earth. (Tadesse G, 2001), the physical loss of the land is visibly manifested. Gullies can grow in both up hill and downhill directions. A heavy rainfall can enlarge a small rill into a big gully overnight. Gully erosion is infect another term for accelerated soil erosion and once it is formed it difficult to stop it from growing and it is very expensive to rehabilitate the land.

The process, in most cases, is related to the activities of man, especially those connected with the destruction of vegetation cover (Vanacker *et al.*, 2003; Sihag *et al.*, 2017). Gully erosion, in contrast to sheet erosion is very obvious because of its disastrous nature and rapid progress.

2.6 Splash Erosion

This is the process of the detachment of soil particles by raindrops. This occurs when raindrops hit on an exposed soil surface free from vegetative cover and the surface is wet. On some soils, a very heavy rain can cause a soil particle to rise or jump as high as 2ft above the ground and move up to 5ft horizontally. In terms of quantity as much as 224t/ha can be splashed up by a very heavy rainfall. Splash erosion even on cropped land is evidenced by the presence of soil particles on the underside of green vegetables. Splash erosion is directly related to the raindrop size and the type of the soil structure. The defaced particles are removed by surface runoff as sheet erosion (Bewket W., 2007).

2.7 Wind erosion

Wind Erosion is the natural process of transportation and deposition of soil by the wind. It is a common phenomenon occurring mostly in dry, sandy soils or anywhere the soil is loose, dry, and finely granulated. Wind erosion damages land and natural vegetation by removing soil from one place and depositing it in another. The main mechanism of wind erosion is wind propelling sand and dirt causing erosion. Over time all the impacts of the loose sand on the rocks starts to make the rocks chip away and erode. Wind erosion is obviously more common in windy areas. Let us take it back to earth science. Erosion is the action of surface processes such as wind that remove soil, rock, or dissolved material from one location on the Earth's crust and then transports it to another location. Wind erosion can be caused by a light wind that rolls soil particles along the surface through to a strong wind that lifts a large volume of soil particles into the air to create dust storms. As wind erosion is the wind-forced entrainment, transportation, and deposition of soil particles it causes devastating global environmental degradation through movement of fine nutrient-rich surface soil particle to water bodies, air and other land surfaces. This in turn decreases cropland productivity and increases the risk to human life. Wind erosion also impairs soil properties such as structure, moisture content, and organic matter, and it is enhanced by the lack of vegetation on the soil surface.

2.8 Consequences of Soil Erosion

Soil is the earth's fragile skin that anchors all life on Earth. It is comprised of countless species that create a dynamic and complex ecosystem and is among the most precious resources to humans. Increased demand for agriculture commodities generates incentives to convert forests and grasslands to farm fields. The transition to agriculture from natural vegetation often cannot hold onto the soil and many of these plants, such as coffee, cotton, palm oil, soybean and wheat, can actually increase soil erosion beyond the soil's ability to maintain it. Half of the topsoil on the planet has been lost in the last 150 years. In addition to erosion, soil quality is affected by other aspects of agriculture. These impacts include compaction, loss of soil structure, nutrient degradation, and soil salinity. These are very real and at times severe issues. (Bewket W. and Geert Sterk, 2005) severe soil erosion is result as a long term activities of human being. And degraded lands are also often less able to hold onto water, which can worsen flooding. Sustainable land use can help to reduce the impacts of agriculture and livestock, preventing soil degradation and erosion and the loss of valuable land to desertification.

The health of soil is a primary concern to farmers and the global community whose livelihoods depend on well managed agriculture that starts with the dirt beneath our feet. While there are many challenges to maintaining healthy soil, there are also solutions and a dedicated group of people, including world wide fund (WWF) who work to innovate and maintain the fragile skin from which biodiversity springs. Some of the greatest effects of soil erosion include:

1. Loss of Topsoil. Obviously, this is the biggest effect of soil erosion.
2. Soil Compaction.
3. Reduced Organic and Fertile Matter.
4. Poor Drainage.
5. Issues with Plant Reproduction.
6. Soil Acidity Levels.
7. Water Pollution.

2.9 Control Measure of Soil Erosion

(Chude, 2005) stated that if one wants to stop soil erosion. He or she should have the following in mind:

- a) Maintaining a healthy, perennial plant cover.
- b) Mulching.
- c) Planting a cover crop such as winter rye in vegetable gardens. Includes annual grasses, small grains, legumes and other types of vegetation planted to provide a temporary vegetative cover. Cover crops are often tilled under serving also as a “green manure” crop.
- d) Placing crushed stone, wood chips, and other similar materials in heavily used areas where vegetation is hard to establish and maintain.
- e) Using other erosion controls that include the use of geo-textile materials or other methods such as sodding or hydro seeding that result in the establishment of permanent cover. These methods work well on steep slopes and heavy traffic areas. Contact your local landscape contractor or the Nursery and Landscape Association.
- f) Addressing problem areas of that get lots of storm water runoff. Solutions to these problem areas include redirecting storm water and roof runoff to areas that can settle and dissipate water, such as a rain garden.

Erosion control is indispensable in view of the expanding economic activity of society and the endeavor to use natural resources purposefully and economically. The objective of erosion control is to protect the two valuable natural resources (soil and water) and to prevent the occurrence of the unfavorable consequence which deterioration could have for various branches of the national economy which are agriculture, water management and human environment (Amsalu A, de Graaff J. 2007). The method of erosion control measures to be adopted depends on the type of erosion and there are two type or control; preventive control measures and curative control measures. The prevention of erosion has always been a much easier, effective and cheaper task than undertaking curative measures of eroded areas which is more expensive.

3.0 MATERIALS AND METHODS

3.1 Study Area

The study was conducted in birshi/mirri ward of Bauchi Local Government Area. It is in the town of Latitude (10° 1' 0" N) and a Longitude (9° 34' 59" E), Distance 33.2km² (20.6 miles), 223.2° (SW) (2016 census).

The majority people speak Hausa language. The major crops grown are sorghum, millet, maize, sesame, groundnut, cowpea, Bambara groundnut and rice.

3.2 Methodology

The data collected for this study were gathered through primary and secondary sources.

3.2.1 Primary Source.

These are information gathered through personal interviews and Questionnaire that the researcher administered to the farmers in the study Area.

Therefore, a structured questionnaire was developed and administered randomly among farmers within the L.G.A.

3.2.2 Secondary source.

These are information collected and gather through published textbook, journals, seminar papers and documented information in libraries.

3.3 Data analysis/Research design.

The data collected through the questionnaire administered to farmers were analysed by means of descriptive statistics, where means are expressed in percentage.

4.0 RESULTS AND DISCUSSION

4.1 Socio Demographic Characteristic of the Farmers.

Table 1 presents the characteristics of the farmers in the study area of the respondent 62% were male while 38% were females. This implies that more males are involved in cultivation (farming) than females. According to responds received by the respondent shows that 50% are married while 23% are single 11% are divorced and 9% are widow and 6% are widower. The majority of the farmers are in the age bracket of 20-30 years 31% and 15%. The average age was 33 years old indicating the problem of ageing phenomenon (Ayinde, 2011)

confronting the farming occupation nowadays. The youths are no longer interested in farming activities thereby migrating to the cities for white collar jobs. Similarly, 54% of the farmers did not attain school and 38% are educated but only 8% graduated high institution. Inadequate education and poverty are two key characteristics which impact on farmers' poor farming decisions and or perceptions which result to soil erosion (Pender and Hazell, 2000). The table 1 shows 52.3% of the farmers depend on farming as their source of income.

4.2 Cause of Erosion and Control Practices.

Table 2 below shows that among the causes of erosion, drought have (16%), both climatic change/variation and rainfall with (12%) respectively and also wind (14%) as one of factors causing erosion and also as indicated by the respondents lack of drainage have 17% while the nature of the soil have the highest percent of 27%.

Table 2 also shows that multiple cropping have (42%) as the control practice method used by the respondents, (23%) of the respondent are using cover crops as their method of erosion control practices while (22%) of respondents used construction of bond to control erosion and only (13%) uses ridges across the slope as the control measure.

Table 4.1 Socio_Demographic Characteristic of the Farmers In Parts of birshi/mirri Ward Expressed As Percentage of Number of Respondents.

Variables	Frequency	Percentage (%)
Gender/Sex		
Male	40	62
Female	25	38
Marital status		
Single	33	51
Married	15	23
Divorced	7	10
Widow/Widower	10	15
Age (Years)		
<20	13	20

29-30	20	31
31-39	12	19
40-49	10	15
Above 50	10	15
Education Status		
No formal education	35	54
Educated	25	38
Graduate	5	8
Farming Experience (Years)		
<4	30	46
6-10	18	27
11-15	7	10
16-20	6	9
Above- 21	4	6
Sources of income		
Government	9	13.84
Private	20	30.76
Farming	32	52.30
Self employed	4	6.15

Source: Field survey, 2022.

Table 4.2 Cause of Soil Erosion and Control practices.

V a r i a b l e s	f r e q u e n c y	P e r c e n t a g e
(%)		

Cause of Soil Erosion

Climate change/variation	8	12
Drought	10	16
Rainfall	8	12
Wind	9	14
Lack of adequate drainage	11	17
Nature of the soil	17	26

Control Practices

Multiple Cropping	27	42
Cover crop's	15	23
Construction of Bonds	14	22
<u>Ridging Across the Slope</u>	<u>9</u>	<u>13</u>

Source: Field Survey, 2022.

4.3 Effect of Soil Erosion and The Type of Soil Erosion.

Table 3 shows that the major effect of soil erosion encountered are reduction in crop yield on their farms (23%), 5 farmers (10%) encountered loss of topsoil, 7 (11%) of the farmers had problem with reduction in soil nutrient 17% and decreased of farm sizes 8% due to heavy rainfall.

According to USDA (2005), improved land management that ensures better resource use and promotes long-term sustainability is basic to future food production and to the economic welfare of rural communities. On the other hand, the type of soil erosion found on respondents' farm faced in the area shows that sheet erosion 49% has high percent, rill erosion

(15%) and wind erosion as the type of soil erosion have 11% and splash has 12% while gully erosion with the least percent (8%).

Table 4.3 Effect of Soil Erosion and Type of Soil Erosion

Variable	frequency	percentage (%)
Effect of Soil Erosion		
Reduction in crop yields	10	15
Losing topsoil	5	8
Reduced nutrient in soil	7	11
Decreased in land size	4	6
Type of Soil Erosion		
Sheet erosion	32	49
Gully erosion	5	8
Rill erosion	10	15
Wind erosion	7	11
Splash erosion	8	12

Source: Field Survey, 2022.

5.0 SUMMARY, CONCLUSION AND RECCOMENDATIONS

5.1 Summary

A research was conducted or done in other to determine the effect of erosion on agricultural farm faced by the farmers in birshi/mirri wards, identify the practices that cause erosion and also assess farmers' perception in relation to the effect of erosion on the agricultural potentials and performance of the communities. The data was collected in form of oral interview where by structured questionnaire was administered to 65 individuals at random among farmers in the Local Government Area. The causes of soil erosion by nature of the

soil as revealed by the farmers 26%, lack of adequate drainage 17% is also the cause of soil erosion. High percent (42%) farmers practicing multiple cropping as control practices. the major effect of soil erosion encountered are reduction in crop yield on their farms (23%), 5 farmers (10%) encountered loss of topsoil, 7(11%) of the farmers had problem with reduction in soil nutrient 17% and decreased of farm sizes 8% due to heavy rainfall. Farmers should have a change of attitude in order to avoid the possible causes of erosion on their farmland. This may be achieved by planting more trees, avoiding deforestation, and overgrazing as well as encouraging the use of those sustainable agricultural practices.

5.2 Conclusion

Based on the research conducted, it could be concluded that the causes of soil erosion by nature of the soil as revealed by the farmers has high percent and ways of controlling the soil erosion includes; construction of band, planting of cover crops, multiple cropping and avoiding planting on a sloppy area.

5.3 Recommendation

It is therefore note worthy to recommends that;

- i. Farmers should have a change of attitude in order to avoid the possible causes of erosion on their farmland. This may be achieved by planting more trees, avoiding deforestation, and overgrazing as well as encouraging the use of those sustainable agricultural practices.
- ii. Extension agents should provide more packages on farmland erosion control practices that will equip the farmers with the technical know-how to face the challenges of erosion on their farms.

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HARNESSING INNOVATION IN AGRICULTURE: DRIVING PRODUCTIVITY AND FOOD SECURITY IN NIGERIA

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ABSTRACT

This study explores the potential of harnessing innovation in agriculture to drive productivity and food security in Nigeria. Against the backdrop of global agricultural challenges and the historical context of Nigerian agriculture, the study investigates the importance of innovation in addressing issues such as low productivity, inadequate technology adoption, and limited access to resources. Drawing on the theoretical framework of Innovation Diffusion Theory, the research examines the challenges hindering the adoption of innovation in Nigerian agriculture, including lack of awareness, high costs, insufficient information, and limited access to inputs and financial resources. Through analysis of existing literature and empirical data, the study aims to provide insights into strategies for promoting innovation adoption among small-scale farmers in Nigeria, ultimately contributing to enhanced agricultural productivity and food security.

Keywords: Agriculture, Innovation, Productivity, Food Security Nigeria.

Introduction

Agriculture is critical to sustainable development and poverty alleviation (Barrows et al., 2014). The global backdrop for agriculture has altered considerably, and despite widespread adoption and development of the agricultural extension program, substantial obstacles persist (Feder et al., 2010). In recent years, phone-based agricultural advising services have expanded to capitalize on the introduction and expansion of mobile phone networks (Fabregas et al., 2019). Some research has proposed both substantial and inconsequential ways in which SMS-based agricultural information might influence farming outcomes (Nakasone et al., 2016). It is uncertain if changes in program design or methodological issues in program evaluation have broad implications (Norton & Alwang, 2020).

The agricultural and food sectors are facing several issues. Food consumption is predicted to increase significantly as the global population grows from 7.6 billion in 2018 to more than

9.6 billion in 2050 (UN DESA, 2019). At the same time, natural resources like fresh water and productive agricultural land are becoming rarer. This rapid population growth will put immense pressure on the agricultural industry to produce more food with limited resources. Sustainable farming practices and technological innovations will be crucial in addressing these challenges and ensuring food security for future generations.

Digital agriculture refers to the use of digital technologies to integrate agricultural output from paddock to customer. Agricultural enterprises can profit from these technologies since they provide additional tools and information for making better decisions and increasing production. Sensors, automation, and robotics are being used in production systems as part of digital farming technology (Banhazi et al., 2012; Shamshiri et al., 2018). These tools can help monitor crop growth, soil conditions, and livestock health in real-time, allowing farmers to optimize their resources and improve efficiency. By utilizing digital agriculture, farmers can also reduce environmental impact and improve sustainability practices in their operations.

In rural parts of developing nations, where the majority of people rely on agriculture for a living, digital technology can help reduce global poverty and hunger faster. Farmers in digital agriculture employ mobile phones and other technology that has the potential to transform community livelihood security and improvement (Kremer & Hounkbo, 2020). By providing access to information on weather patterns, market prices, and best agricultural practices, digital technology can increase crop yields and income for farmers. This ultimately leads to improved food security and economic stability in these communities.

Although agricultural output is already adequate to feed the globe, 821 million people remain hungry (FAO, 2018). Rapid urbanization has a profound influence on food demand and supply patterns. The agrifood industry is crucial for livelihoods and jobs. Over 570 million smallholder farms exist globally (Lowder et al., 2016), and agriculture and food production employ 28% of the global workforce (ILOSTAT, 2019). To accomplish the UN Sustainable Development Goal of a "world without hunger" by 2030, food systems must be more productive, efficient, sustainable, inclusive, transparent, and resilient (FAO, 2017). The present agrifood system will have to be altered quickly. This will require significant investments in research, technology, infrastructure, and policy changes to ensure food security for all. Collaboration among governments, businesses, and communities will be essential to address the challenges of food insecurity and create a more sustainable future for agriculture and food production.

It against this backdrop, this study seeks to investigate **harnessing innovation in agriculture: driving productivity and food security in Nigeria**

Overview of Agriculture in Nigeria

Agriculture is described as the art or science of growing foods and raising animals for human benefit. It has also been defined as the science, art, or practice of cultivating soil, growing crops, and keeping livestock for the ensuing products (Marriam-Webster, 2021). Essentially, agriculture cultivates both food and cash crops and raises various types of animals in order to create food for humans and raw materials for agro-allied businesses. According to Aremu et al. (2010), the most significant job of agriculture in every nation is to provide food, which is also required by humans for energy, body construction, cell repair, and body defense. Vegetables, fruits, grains, legumes (including dry beans, spices, herbs, seeds, and nuts), beverage plants like tea, cassava, maize, potatoes, rice, sorghum, soya beans, sweet potatoes, wheat, and yams are examples of food crops. Cash crops, on the other hand, are agricultural commodities grown primarily for the purpose of selling them to local businesses or exporting for profit. It is also known as a profit crop and is often acquired by parties outside of a farm. The word distinguishes between sold crops and subsistence crops, which are grown for human consumption.

Subsistence agriculture was the norm in pre-colonial Nigeria, with farmers focusing on cultivating and producing food crops to sustain themselves and their families. Although the building was not static, it needed a family and a large plot of land on which members of the family utilized rudimentary and crude equipment to cultivate food for the household. Environmental and climatic considerations influenced farming techniques in widespread communities (Alexander, 2022). For example, in the northern region of Nigeria, farmers adapted their practices to the arid conditions by utilizing irrigation methods such as digging wells and constructing channels to water their crops. In the southern region, where rainfall was more abundant, farmers relied on natural precipitation for their agricultural needs.

According to Faluyi in Kehinde (2013), the origins and dissemination of agriculture are unclear, although it is widely agreed that knowledge of agriculture began in Egypt in the late sixth or early fifth millennium B.C. He went on to say that the early Egyptians most likely learned about crop and animal domestication from the inhabitants of Syria and Mesopotamia, who had been practicing the skill during that time period. However, not all researchers agree

with this perspective, which holds that agriculture in West Africa originated in North Africa and is commonly associated with the Hamitic theory. Wickins, for example, claims that agriculture in Sub-Saharan Africa arose independently of Egypt, although three millennia later (Oyemakinde, 2005). The old version asserts that after agriculture was developed in Egypt, it formed a new center from which knowledge moved southward to other communities such as Nigeria. According to the same source, grain farming, specifically wheat and barley, began in the Near East 10,000 years ago and moved up the Nile Valley and westward via the Savannah Corridor to West Africa around 1500 years before Christ.

Wickins further argued that the conducive environment with abundant resources of the tropical savannah provided the small realistic hunting communities with all they needed in terms of food supply and gave them nearly the same living standard, so they did not see the need to develop cereals and domesticate flocks, resulting in a time lag in agricultural advancement (Alexander, 2022). Whatever the debate over crop domestication and the transition to an agrarian economy as opposed to the hunting period, Africans, particularly those in Sub-Saharan Africa, borrowed and adapted several crops at an early date, including several types of millet, yams, an indigenous form of groundnut, oil palms, and rice.

Land has long been an important role in production, is essential for farming, and is regarded as a source of life. Land was communally owned and allocated based on the requirements assessed by the household head. As the population grew, the community land was continually redistributed. Farming was augmented with other occupations including as animal husbandry, hunting, fishing, manufacturing, and collecting, and agriculture eventually became the principal activity of all Nigerian ethnic groups. Agriculture was referred to as "the Igbo staff of life" among the Igbo. Every Igbo man and woman were farmers. Most families produced enough basics including yam, cocoyam, cassava, and vegetables (Adewoye 2011). Similarly, the Yorubas and Hausas, the Edos, Igala, Nupe, Isan, Ibibio, and Efik, among others, made farming their primary employment.

As much as the colonial officials desired complete control, the practical realities of the situation required them to allow Nigerians to take some initiative in the direction of their economic affairs. Infrastructural changes such as rail and road construction and certain export crops such as cocoa, coffee, electricity, and currency benefited the traditional economy by strengthening its ties to the global economy, but they also made it vulnerable to global risks such as the 1930s economic depression. It should also be noted that the colonial period saw

the introduction of money, with the British government introducing pounds, shillings, and pence as well as additional agricultural incentives to encourage output (Alexander, 2022). Additionally, the colonial period brought about changes in land ownership and labor systems, impacting the traditional economy's structure. These shifts often led to social unrest and resistance among local populations against colonial rule.

According to Akindele (1988), for a long time, and until the end of the 1960s, Nigeria's economic growth and development were primarily stimulated and driven by agricultural output for export. Because more than 70% of Nigeria's working population is engaged in peasant and non-mechanized agriculture, no economic historian can ignore the agricultural sector's nerve-centeredness and multidimensional importance in the Nigerian nation's social and economic life, despite the fact that agriculture's share of GDP has been steadily declining since 1960. Nigeria's agricultural resource strength and potential, as previously said, are defined and determined by the country's geographical position, terrain, climate, soil, and vegetation. The typical variety of the country's agricultural resources, which range from 40 to 140 degrees north of the equator. This geographical location allows for the existence of a wide range of distinct and diverse ecological zones, including the mangrove swamp, high forest, guinea savannah, and dry Savannah, all of which contribute to and enable the existence of a variety of agricultural production for both domestic consumption and export.

Nigerian agriculture has traditionally suffered from a general problem of low productivity resulting from nonmechanization, low level of agricultural technology, insufficient or misapplication of fertilizers and pesticides, poor production techniques, an archaic system of land tenure, and underinvestment. Notwithstanding the launching of the agriculture revolution schemes, it is obvious that with the state of the dwindling fortunes of the country in the agricultural sector, there is a need for a much greater allocation and a more spirited mobilization for the agricultural sector of the economy (Alexander, 2022). Furthermore, there is a need for comprehensive training and education programs to improve the skills and knowledge of farmers. Implementing modern farming techniques and technologies can also help increase productivity in the agricultural sector.

Importance of Innovation in Agricultural Development

Agriculture is one of the oldest sectors in every economy. It is an important sector since its purpose is to supply nutrition to the populace. The fundamental factor in production is land,

which has a restricted size. It is an irreversible factor with a fixed size (Kuzevicova et al., 2013). Thus, growing agricultural output requires more effective land use and the use of cutting-edge expertise. In many nations, agriculture that incorporates innovative features is an important engine of economic development (Ayodele et al., 2019). Agriculture has provided great advantages. Agriculture has always been one of the country's most important economic sectors (Popov, 2017). Furthermore, agriculture plays a crucial role in providing employment opportunities for a significant portion of the population, especially in developing countries. Additionally, advancements in agricultural technology have led to increased productivity and efficiency in the sector, contributing to overall economic growth.

Currently, the growth of any sector requires adhering to the principles of sustainability, which include economic, social, and environmental development. Furthermore, farming is an important sector for guaranteeing sustainable growth. Environmental challenges are becoming increasingly important in generating more significant economic growth. Globalization and urbanization have an impact on lifestyles and consumer behavior. Sustainable economic growth entails promoting environmentally friendly policies at all financial levels as well as transforming consumption and production so that human and economic activities contribute to a sustainable society (Aceleanu, 2016). It is crucial for governments and businesses to prioritize sustainability in their decision-making processes to ensure long-term success. By investing in renewable energy sources and promoting green technologies, countries can achieve a balance between economic growth and environmental preservation.

Agriculture's relevance is not determined by its size or percentage of total economic production. This sector's performance accounts for a minor portion of the global economy, yet it remains vital to many people's daily lives. Life is impossible without the goods of this industry (Dobrovic et al., 2016). Agriculture provides the food and resources necessary for survival, making it a crucial component of society. Its impact extends beyond economic measures, influencing everything from culture to health.

Theoretical Framework

This study adopts Innovation Diffusion Theory as the theoretical framework of analysis.

Rogers (1995) improved on the Innovation Diffusion Theory, which was first proposed in 1962. Innovation diffusion theory seeks to understand how, why, and at what pace creative

ideas and technology spread within a social system. Rogers' work expanded on the original theory by incorporating factors such as communication channels and social systems, providing a more comprehensive framework for analyzing innovation adoption. This enhanced understanding has since been widely applied in various fields, including marketing, sociology, and public health.

Innovation Diffusion theory provides a different method for studying changes than other change theories. Instead of focusing on convincing people to change, it sees change as largely about the development or "reinvention" of goods and behaviors to make them more suited to the requirements of individuals and communities. The inventions themselves change, not the individuals who spread them (Les Robinson, 2009). Innovation diffusion theory emphasizes the importance of understanding how innovations are adopted and spread within a society. By recognizing the role of social networks and communication channels in this process, it offers insights into how to effectively introduce new ideas or products.

Everett Rogers created this theory, which may be used to better understand how new agricultural technology and practices are embraced and disseminated among Nigerian farmers. It investigates how innovations are conveyed through specific channels throughout time among members of a social system. Understanding the diffusion process can assist in developing successful methods for propagating novel agricultural techniques and technology throughout Nigeria's agricultural landscape.

Challenges hindering the adoption of innovation in Nigerian agriculture

The widespread lack of awareness among small-scale farmers may contribute to their high prevalence of illiteracy. This contributes to the widespread acceptance of current innovation. The nature of the distribution of innovation influences its acceptance. Agricultural demonstrations and personal interaction between farmers and extension agents have been linked to the adoption of certain innovations (Adeyemi et al., 2023). Therefore, increasing access to educational resources and training programs for small-scale farmers can help improve their literacy levels and ultimately enhance their acceptance of new innovations in agriculture. Additionally, creating more opportunities for direct engagement and knowledge-sharing between farmers and extension agents can further facilitate the adoption of innovative farming practices.

Obisesan (2014) identified the following restrictions to the adoption process of most innovations: high costs of innovation, non-availability of required inputs, a lack of suitable information, and insufficient financial facilities. These restrictions often hinder farmers from fully embracing new technologies or practices, ultimately limiting their ability to stay competitive in the market. Overcoming these barriers requires strategic planning and investment in resources to facilitate the successful adoption of innovations.

Simtowe et al. (2011) believe that the use of newer technology is impacted by a shortage of agricultural inputs, high labor costs, and land tenancy, among other reasons. Adoption of innovation is heavily influenced by the type and efficacy of communication channels. Therefore, it is crucial for agricultural extension services to effectively communicate the benefits and methods of using new technologies to farmers. Additionally, government policies and incentives can play a significant role in encouraging farmers to adopt innovative practices in agriculture.

According to Ekpe and Obetaan (2004), the frequency of extension contact has a considerable impact on agricultural technology adoption. One of the key impediments to innovation adoption is farm product price regulations as well as investment in physical and social infrastructures, which are largely geared toward urban people and industry (Mwangi&Kariuki, 2015). These factors contribute to the limited access and dissemination of agricultural technologies to rural farmers, hindering their ability to adopt new innovations. Addressing these challenges through targeted policies and investments can help improve technology adoption rates in rural areas.

Conclusion and Recommendations

Agriculture innovation is critical to increasing production and guaranteeing food security in Nigeria. Despite the historical importance of agriculture to the country's economy and the immense potential given by its different natural zones, Nigerian agriculture confronts several problems that hamper its growth and development. These issues include low productivity, insufficient technology adoption, restricted resource availability, and inadequate infrastructure. The theoretical framework of Innovation Diffusion Theory provides valuable insights into understanding how new agricultural technologies and practices are adopted and disseminated among Nigerian farmers. By acknowledging the role of communication

channels and social systems in the diffusion process, strategies can be devised to effectively introduce and promote innovative agricultural solutions.

However, adoption of innovation in Nigerian agriculture is hampered by a number of problems, including widespread illiteracy among small-scale farmers, high innovation costs, restricted access to inputs and information, and poor extension services. Overcoming these difficulties will need a collaborative effort from the government, lawmakers, agricultural groups, and stakeholders.

Based on the findings the following recommendations were suggested:

- i. Improve literacy and education levels among small-scale farmers through targeted educational programs and training initiatives.
- ii. Enhance access to information and extension services by investing in digital platforms and communication technologies tailored to the needs of rural farmers.
- iii. Reduce the cost barriers associated with innovation adoption by providing financial incentives, subsidies, and access to credit facilities for farmers.
- iv. Strengthen agricultural input supply chains and infrastructure to ensure the availability and accessibility of necessary resources for farmers.
- v. Promote policies that incentivize the adoption of sustainable and environmentally friendly farming practices, such as conservation agriculture and organic farming.
- vi. Enhance collaboration and partnerships between government agencies, research institutions, NGOs, and private sector entities to facilitate technology transfer, knowledge sharing, and capacity building in agriculture.
- vii. Prioritize investments in rural development and infrastructure projects to address the disparities between urban and rural areas, thereby improving access to agricultural technologies and markets for rural farmers.

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FACTORS INFLUENCING COST MANAGEMENT PRACTICE OF CONSTRUCTION FIRMS: LESSONS FROM NORTH-CENTRAL NIGERIA

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ABSTRACT

The growing need at maintaining steady cost projection of construction projects has been an issue of serious concern to both the clients and the construction practitioners on sites. Also, cost deviation from initial cost plan and cost budget has been prevalent on construction sites. This study therefore assesses the factors that are considered to be affecting the cost management practice of construction firms in the north central Nigeria and also proffered possible ways of ameliorating the factors. A structured questionnaire was used to elicit data from

construction-related professionals. With recourse to 80 valid questionnaire retrieved, data were analyzed using simple percentile and mean score of 5-point Likert scaled responses. The results revealed that inefficient deployment of resources, excessive wastage of materials on sites, poor leadership/inappropriate management and among others related factors affecting construction cost management practice in the study area. It was concluded that more effort should be placed on identified factors with a view of enhancing construction performance within the study area.

KEYWORDS: Construction firms; Cost management; Influencing factors; North-central Nigeria.

1.0 INTRODUCTION

The construction sector has proven to be a critical sector that should not be ignored in the life of the economy of any nation (Abiodun & Nwaogu, 2021). This is because the construction industry is the economic backbone of nations, as the industry provides jobs and projects growth in other sectors of the economy (Onyejeakor, Onyeagam, & Adegboyega, 2020; Onyeagam, Eze, & Adegboyega, 2019). In spite, of the impact of the sector on the life of nations, construction projects suffer from delayed completion, cost overruns, poor quality and materials shortages, among others. Numerous developmental projects in Nigeria have failed to meet client needs and project requirements, as a result of poor cost management and performance strategies put in place by construction organizations. This is a situation in which the project exceeds its initial planned schedule and cost budgets. This has remained a recurring issue affecting a lot of construction projects both in developed and developing economics (Obi, Arif & Kulonda, 2017; Odediran & Windapo, 2014). Construction firms are the major actors whose management experiences impact the project and customer satisfaction. According to Tejas (2020), construction companies execute construction projects of public or private nature that require proper management and coordination with the aim of resources maximization, continuous work progress, revenue generation and profitability, growth and survival of their businesses. A common problem in the construction sector is that of effective cost management of construction projects. It is one of the areas that contractor should focus on as it attempts to manage its project portfolio (Tejas, 2020). Cost management practices involve all efforts in ensuring that construction projects are delivered within cost, time and quality (Fagbenle, Joshua, Afolabi, Ojelabi, Fagbenle, Fagbenle, & Akomolafe, 2018). This is supported by the submission of Phanse et.al (2021) who posited that cost overrun occurs where project management is incompetent to sufficiently monitor projects activities and processes from the beginning of the project to the end. Barroso and Armando (2020) opined that cost management contributes to the development of strategies for attaining a competitive advantage. Previous studies were carried out in Nigeria by Odediran & Windapo

(2014), Obi et al. (2017), Fagbenle et al. (2018), Reuben, Okereke, Mohammed, & Eze (2022) from southwestern and south-south geopolitical zones of Nigeria, despite that the construction stakeholders know how important project cost is, and the impact it has when properly managed. It is against this backdrop that this study assessed the cost management practice of construction firms and its influencing factors.

This study is aimed at assessing the factors influencing the cost management practices of construction firms in North-Central Nigeria. In pursuit of this aim, the objectives of the study include:

1. to identify the factors influencing cost management practices;
2. to assess the magnitude of the impact of the factors influencing cost management practices; and
3. to prioritize the factors influencing cost management practices.

It is expected that the lesson learnt regarding the influencing factors of cost management practices in North-central Nigeria would pave the way for enhanced construction performance within and beyond the study area.

2.0 LITERATURE REVIEW

2.1 COST MANAGEMENT IN CONSTRUCTION PROJECTS

Relevant literature revealed that project cost management and control is important, yet construction organization are yet to develop effective cost management practices in their operations, especially in the construction industry of a developing country like Nigeria. While the majority of the studies on cost management were carried outside Nigeria (Petara& Thakkar, 2012; Tejas, 2020; Albtoush et.al., 2020; Iyer & Jha, 2005; Divakar & Jebin, 2018; Meampol& Ogunlana, 2006; Olawale & Sun, 2010; Zhao et al., 2017; Ronald & Agung, 2018; Miri &Khaksefidi, 2015; Annor-Asubonteng et al.,2018; Chigara et al., 2013; Kissi et al. 2016; Barroso and Armando, 2020), only few of such studies were carried out in Nigeria by Obi et al., (2017), Fagbenle et al. (2018), Odediran and Windapo (2014) and Reuben et al., (2022).

Construction cost management is the process of keeping projects on budget. For general contractors, this keeps projects from overspending and chewing away at their bottom line (Ashworth, 2010). Cost management involves getting a clear grasp of how and why costs are

incurred on a project and taking critical measures to ensure that the planned project budget is not exceeded. The benefits of effective project cost management that have captured the attention of clients (public and private) are its ability to guarantee improved value for money and satisfaction of the clients (Gopalan, & Venkataraman, 2015; Obi et. al. 2017). In developed countries like the UK, concerted efforts have been made by the government to develop a detailed cost management guideline to help organizations involved in the delivery of public-funded projects to achieve effective project cost management (United Kingdom Office of Government Commerce, 2007). In addition efforts are being made in various countries to develop similar cost management guideline to improve value for monies and ensure the satisfaction of parties to public projects (Obi et. al., 2017). Tejas (2020) advocated for holistic management of materials, plant and equipment, to ensure the cost of projects are kept within budget, bearing in mind that cost management is not an easy task, since project managers would have to be confronted with a lot of issues that required proactive balancing to ensure that their impact on project success is minimized.

2.2 FACTORS INFLUENCING COST MANAGEMENT PRACTICE

There are factors of critical importance that tend to influence cost management practices of construction firms in the course of project implementation. From the southwestern part of Nigeria, Fagbenle et al. (2018) found that the dominant factors influencing cost management practices of construction firms include poor and inappropriate leadership and management, poor resources deployment, materials wastage on site, complex payment mechanisms, frequent issues of variations during construction, and materials theft on site. From the south-south geopolitical zone of Nigeria, Reuben et al. (2022) found that the critical factors influencing cost management practices of construction firms include poor leadership and coordinating skills, poor resources deployment, excessive material wastages on site, complex payment mechanism, variations/design changes during construction, materials theft on sites, weak management support and control, unstable construction materials prices, poorly developed projects brief and insufficient project information. Divakar & Jebin (2018) assessed the factors influencing effective cost management process implementation in construction and found that the top 14 factors include unrealistic schedule imposed in the contract, poor scope definition, inaccurate estimation of direct and indirect cost, inaccurate activity cost estimate, misallocation of direct, indirect and joint cost, ineffective frequency of project budget updates, poor work breakdown structure (WBS) definition, change in

schedule, weak regulation and control, often changing subcontractors, lack of proper training and experience of project manager, low productivity of labour, poor updating of cost management, information systems, and not implementing project management tools for monitoring and control. Annor-Asubonteng, Tengan, Asigri, & Napoleon, (2018) averred that one of the vital factors causing poor cost management practices is insufficient project information for accurately estimating the project cost. Zhao, Mbachu, & Domingo (2017) in new Zealand, found the factors requiring adequate monitoring and control in cost management situations to include market conditions, key stakeholder's influences, regulations regarding building and construction, and external economic environment. Detailed in table 1 is a systematic visualization of the various factors influencing cost management practices of construction firms and their various sources in literature.

Table 1: Factors influencing cost management

S/N	Factors influencing cost management	Sources
1	Inefficient deployment of resources	Fagbenle et al. (2018), Meeampol and Ogunlana (2006), Reuben et al. (2022)
2	Excessive wastage of materials on site	Fagbenle et al.(2018), Reuben et al.(2022). Enshassi et al (2006).
3	Poor leadership/management skill	Fagbenle et al. (2018), Reuben et al. (2022), Enshassi et al. (2006).
4	Poor management of risks	Reuben et al. (2022), Olawale & Sun (2016).
5	Ineffective communication	Annor-Asubonteng et al. (2018), Obi et al. (2017)
6	Complex payment mechanism	Fagbenle et al. (2018)

- 7 Poor estimation of project time and costs Reuben et al. (2022), Olawale& Sun (2010)
- 8 Unstable construction material prices Reuben et al. (2022), Iyer and Jha (2005), Zhao et al. (2017).
- 9 Materials theft on site Fagbenle et al. (2018), Reuben et al.(2022); Enshassi et al. (2006).
- 10 Poorly developed project brief Divakar and Jebin (2018).
- 11 Lack of experience in managing project cost Reuben et al. (2022), Divakar and Jebin (2018).
- 12 Incorrect estimation methods Reuben et al. (2022), Meeampol and Ogunlana (2006);
- 13 Weak management support and control Fagbenle et al.(2018), Obi et al.(2017).
- 14 Poor contract administration and management Annor-Asubonteng et al. (2018).
- 15 Insufficient project information Divakar and Jebin (2018), Obi et al.(2017).
- 16 Project design changes/modification Fagbenle et al.(2018).
- 17 Poor price during tendering Reuben et al. (2022).
- 18 Unexpected ground condition Annor-Asubonteng et al. (2018).
- 19 Poor updating of cost management information systems Divakar and Jebin (2018).

20 External economic environment

Zhao et al. (2017), Obi et al.(2017).

Meanwhile, Obi et al.(2017) found that the quality of the project team, information availability, management actions and external environment, shortage of skilled personnel, building materials unavailability in local market, variations and weak cost control systems to constitute some of the impediments to successful cost management practices.

3.0 RESEARCH METHOD

This study deployed the survey methodology involving the use of structured questionnaire for data collection. A total of 120 questionnaires were administered to five groups of construction professionals namely Architects, Builders, Quantity Surveyors, Engineers, and Project Managers across the six states of North-central geopolitical zone of Nigeria comprising Kogi, Benue, Nasarawa, Plateau, Niger and Kwara states. The questionnaire comprises two sections namely A and B. Section A elicited background data about the respondents, while section B elicited data pertaining to the aim and objectives of the study.

For the analysis of data, combinations of quantitative tools were deployed. First was the frequency distribution tool for data classification (See Salvatore and Regeale, 2002), comprising frequency distribution tables, percentiles, arithmetic mean. The study adopted a variant of arithmetic mean known as the mean item score to obtain a quantitative equivalent of the average response provided by respondents in accordance with a 5-Point Likert scale. This Mean item score were targeted at analyzing and ranking the specific factors influencing cost management practice of construction firms identified in section 2.2 above. The formula for computing this variable is given as:

$$\text{Mean} = \frac{\sum fw}{\sum f} = \frac{(5 \times f_5) + (4 \times f_4) + (3 \times f_3) + (2 \times f_2) + (1 \times f_1)}{f_5 + f_4 + f_3 + f_2 + f_1}$$

Where $\sum fw$ is the sum of the product of all weights and $\sum f$ is the total number of actual respondents.

Table 2: Criteria for the ranking of factors based on the mean item score

Range of Mean score	Interpretation
$4.90 \leq \text{MIS} \leq 5.00$	Very high impact
$3.70 \leq \text{MIS} \leq 4.89$	high impact
$2.50 \leq \text{MIS} \leq 3.69$	moderate impact
$1.30 \leq \text{MIS} \leq 2.49$	Low impact
$0.00 \leq \text{MIS} \leq 1.29$	Very low impact

Accompanying the mean item score as a tool of data analysis is the deployment of ranking of mean score. Hence, for the 5-point Likert scale where 5 is the highest score, and 1 being the lowest score, the ranking on the basis of the mean score was guided by the criteria indicated in Table 2.

4.0 DATA ANALYSIS, PRESENTATION AND DISCUSSION OF RESULTS

4.1 Questionnaire response rate

A total number of 120 questionnaires were distributed, 30 out of the total survey showed no response so that a total number of potential responses was 90. Out of this 90 retrieved questionnaire, only 80 (representing 67% response rate) were validated and adjudged to have been adequately completed in support of the data analysis.

Table 3: Background information about respondents

Category	Classification	Freq.	Percent (%)
Academic qualification of respondents	MSC/MTech/MEng	10	12.50
	PGD	20	25.00
	BSC/BTech/BEng	35	43.75
	HND	15	18.75
	Total	80	100.00
Professional affiliation of respondents	Architect	20	25.00
	Quantity Surveyors	30	37.50
	Engineers	10	12.50

	Builders	11	13.75
	Project managers	9	11.25
	Total	80	100.00
Years of experience in construction	1 – 5	5	6.25
	6 – 10	10	12.50
	11 – 15	15	18.75
	16 – 20	20	25.00
	21 – 25	30	37.50
	Total	80	100.00
	Average years of experience:		16.75 years
Type of organization / firms	Contracting	30	37.50
	Consulting	25	31.25
	Client	25	31.25
	Total	80	100.00

Source: Field Work, 2024

4.2. Background Information About Respondents

Table 3 indicates that holders of first degrees (BSc/BTech/BEng) constituted the highest category of respondents in the sample. It can be deduced from the highest academic qualification of respondents that they have attained a reasonable level of higher education necessary for the performance of their professional tasks. It is further deduced from Table 3 that Quantity Surveyors constituted the highest number of respondents owing to their active involvement in the pricing of building materials and contract execution process. The sample of respondents appear to have amassed an average of 16.75years' experience in the construction sector, whereas the modal class of between 21 and 25 years' experience implied that a substantial proportion of the respondents have amassed experience within the range of 21 to 25 years in the construction industry to avow a measure of authority in the responses they have availed in the course of the survey. The fourth item in Table 3 indicates that 30 (37.50%) are contractors, 25 (31.25%) are consultants, and 25 (31.25%) are clients. This result indicates that there is a high response rate from contractors compared to the other classes of respondents. It is evident therefore, that the data collected for analysis are reliable to form good basis for this study, judging from the distribution of respondents- and their experience in the construction industry.

4.3 PRESENTATION OF RESEARCH FINDINGS

It is observed from the result of data analysis presented in Table 4 that the top five (5) factors that exert high impact on cost management practice include inefficient deployment of resources (\bar{X} = 4.00, SD = 1.03), Excessive wastage of materials on site (\bar{X} = 3.95, SD = 1.12), Poor leadership/management skill (\bar{X} = 3.90, SD = 1.21), Poor management of risks (\bar{X} = 3.83, SD = 1.33), Inefficient communication (\bar{X} = 3.74, SD = 1.45). These factors were observed to have indicated mean score in range: $3.70 \leq \text{MIS} \leq 4.89$.

In the second category are twelve (12) factors found to have exerted moderate impact/influence on cost management practice pursuant to mean score in the range of $2.50 \leq \text{MIS} \leq 3.69$. These factors include complex payment mechanism (\bar{X} = 3.68, SD = 1.52), poor estimation of project time & costs (\bar{X} = 3.60, SD = 1.52), unstable construction material prices (\bar{X} = 3.55, SD = 1.60), materials theft on site (\bar{X} = 3.50, SD = 1.65), poorly developed project brief (\bar{X} = 3.45, SD = 1.74), lack of experience in managing project cost (\bar{X} = 3.35, SD = 1.71), incorrect estimation methods (\bar{X} = 3.23, SD = 1.65), weak management support and control (\bar{X} = 3.10, SD = 1.58), poor contract administration and Management (\bar{X} = 2.88, SD = 1.50), insufficient project information (\bar{X} = 2.71, SD = 1.59), project design changes/modification (\bar{X} = 2.56, SD = 1.32), and poor price during tendering (\bar{X} = 2.50, SD = 1.23).

With a mean score in the range: $1.30 \leq \text{MIS} \leq 2.49$ in Table 4 are the third category of factors found to have exerted low impact/influence on cost management practices among the respondents to include unexpected ground condition (\bar{X} = 2.48, SD = 1.19), poor updating of cost management Information systems (\bar{X} = 2.45, SD = 1.16), and external economic environment (\bar{X} = 2.43, SD = 1.14) respectively.

Table 4: Factors Influencing Cost Management Practice

S/N	Factors Influencing Cost Management	Total	Mean	StDev	Rank
1	Inefficient deployment of resources	80	4.00	1.03	1 st

2	Excessive wastage of materials on sites	80	3.95	1.12	2 nd
3	Poor leadership/management skill	80	3.90	1.21	3 rd
4	Poor management of risks	80	3.83	1.33	4 th
5	Inefficient communication	80	3.74	1.45	5 th
6	Complex payment mechanism	80	3.68	1.52	6 th
7	Poor estimation of project time & costs	80	3.60	1.52	7 th
8	Unstable construction material prices	80	3.55	1.60	8 th
9	Materials theft on site	80	3.50	1.65	9 th
10	Poorly developed project brief	80	3.45	1.74	10 th
11	Lack of experience in managing project cost	80	3.35	1.71	11 th
12	Incorrect estimation methods	80	3.23	1.65	12 th
13	Weak management support and control	80	3.10	1.58	13 th
14	Poor contract administration and Management	80	2.88	1.50	14 th
15	Insufficient project information	80	2.71	1.59	15 th
16	Project design changes/modification	80	2.56	1.32	16 th
17	Poor price during tendering	80	2.50	1.23	17 th
18	Unexpected ground condition	80	2.48	1.19	18 th
19	Poor updating of cost management Information systems	80	2.45	1.16	19 th

20	External economic environment	80	2.43	1.14	20 th
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Source: Field Work, 2024.

The results aligned with findings in related studies by Enshassi et al. (2006), Iyer and Jha (2005), and Fagbenle et al. (2018) where it was found that poor resources allocations and management in construction projects was attributed to inefficient deployment of resources, wastage of material on sites, and poor leadership/management skills. Underlying these findings is the discovery of the project managers' competence as a key determinant of a project's success. Therefore, knowledge of- and skill in cost management skill is vital to the project manager's functions since the need to implement projects within budgetary thresholds is crucial to the realization of a successful project.

Beside the aforementioned, other factors affecting cost management practice include materials theft on sites, inefficient communication, poor management of risks, complex payment mechanism. Enshassi et al. (2006), Reuben et al. (2022), and Fagbenle et al. (2018) stated that ineffective communication on a construction project appear to be among the major causes of cost overrun and conflict on construction projects. Further aligning with the results in Table 4 is the assertion by Annor-Asubonteng et al. (2018), Meeampol and Ogunlana (2006), and Obi et al. (2017) that poor estimation of project time and costs, unstable construction material prices can equally lead to cost overrun and abandonment of projects.

In tandem with Divakar and Jebin (2018), Reuben et al. (2022), and Fagbenle et al. (2018) where it was found that poorly developed project briefs, poor design changes/modification, poor price during tendering and poor updating of cost management of information systems might create problems during the construction phase, this study has found that some of these factors notably poorly developed project briefs and insufficient information for update of construction cost tend to exert moderate impact compared to poor pricing in the course of tendering, which does not appear to pose any significant impact on the cost management practices in the study area. Contrary to the findings from similar studies by Zhao et al. (2017), Obi et al. (2017), and Reuben et al. (2022), project design changes/modification, and influence of the external economic environment posed moderate- and low impacts on cost management practices in the study area compared to the first five factors namely inefficient

deployment of resources, excessive wastage of materials on sites, poor leadership/management skill, poor management of risks, and inefficient communication.

CONCLUSION AND RECOMMENDATIONS

The importance of a sound cost management practice cannot be over emphasized if the owners' objectives are to be realized in all ramifications. Therefore, the realization of sound management practice in construction cost management is anchored on efficient deployment of resources comprising labour, plants and materials on sites, and ensuring adequate and proper management of materials on sites. Also, clear, simple and concise payment mechanism of labour and other operative should be instantiated. In addition, all plants hired on sites must be fully utilized to justify their purpose. Adequate security should be provided on site to curb the incidence of materials theft. Besides the realistic budgeting and estimation of project resources on site, a formidable system of inventory management should be put in place to equally avert theft of materials on sites. The completeness and clarity of project briefs should be pursued by the construction team in order to minimize resource wastage. Meanwhile, the design of the project must meet planning and statutory requirements. The project's design must be coordinated and should take into consideration, the constructability, maintainability, health, safety and sustainability of the proposed building. Finally, concerted efforts should be put in place to instill vigilance, due diligence, and to value engineer construction projects with the purpose of reducing/saving costs, enhancing project functionality and performance, curbing corrupt practices, and promoting the confidence of clients and project owners that they can still get adequate value for money expended on construction projects.

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**EXAMINATION OF THE RELATIONSHIP BETWEEN ENTREPRENEURIAL
ORIENTATION AND FAMILY BUSINESS PERFORMANCE: AN EMPIRICAL
REVIEW**

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ABSTRACT

This research seeks to investigate how entrepreneurial orientation impacts the performance of family businesses. The motivation for this study stems from the frequent failures experienced by family businesses, often attributed to inadequate business orientations that hinder success. Contributing factors include limited financial resources, subpar infrastructure, unfavorable government policies, insufficient sales, and excessive taxation, all of which contribute to significant failures. The findings of the study demonstrate a notable correlation between entrepreneurial orientation and improved family business performance. This discovery carries significant implications, as it can assist family businesses in devising effective strategies for business management. The study introduces a novel model that examines both direct and indirect roles in evaluating family business performance. The research relied on secondary data and revealed a positive and significant relationship between proactiveness, innovativeness, and risk-taking with the performance of family businesses in Nigeria. The study concludes that businesses with an entrepreneurial orientation tend to lead their industries through innovative practices, enhancing customer satisfaction and providing the business with a competitive edge. As a recommendation, the study suggests that family business owners and managers should prioritize commitment to continuous improvement and radical innovation in their operations to expand their customer base and enhance overall performance.

Keywords: Entrepreneurial Orientation, Entrepreneurial Dimensions, Family Business, Family Business Performance.

Introduction

Family businesses hold a distinguished position in the history and global economy, exerting a significant influence on both developed and developing nations. As one of the earliest forms of business organization, dating back to the origins of agriculture, farming, and craftsmanship, family businesses have played a pivotal role in shaping the business landscape. In today's fiercely competitive business environment, they remain a dominant force worldwide. On this note, family members are influenced to get involved in family business through the interactions among the family members that are initiated by the founder (Agbim, 2022).

Within the context of Nigeria, the proliferation of family-owned enterprises has intensified competition, leading to the gradual exit of businesses lacking internal and external strengths. Anwar *et al.* (2023) highlight that family businesses exhibit a strong entrepreneurial orientation, often engaging in innovative ventures encompassing products, processes, and services. This entrepreneurial spirit is fostered by deep family involvement, kinship ties, and social connections.

The enduring success of family businesses hinges on the notion of maintaining ownership within the family across generations, ensuring continuity and control. This enduring model has a substantial impact on Nigeria's economy, attracting significant attention from research

endeavours that explore various aspects of family business dynamics, transcending borders beyond Nigeria.

Hence, this research delves into the correlation between entrepreneurial orientation and the performance of family businesses, defining entrepreneurial firms as those that actively pursue innovation, are proactive, and willing to take risks. These attributes collectively create an environment where such firms can capitalize on opportunities more effectively. The impetus for this study stems from the recurrent challenges faced by family businesses, particularly their struggles with inadequate business strategies that hinder success. Family-owned businesses in Nigeria encounter various obstacles in their quest for sustainable growth and profitability. Scholars have identified several factors contributing to the failure of these enterprises, including limited access to financing, waning family interest, unfavourable governmental regulations, insufficient support in business development services, and burdensome taxation. Consequently, this study focuses on entrepreneurial orientation and its critical dimensions as significant barriers affecting the performance of family businesses in Nigeria.

Literature Review

Initially, entrepreneurial orientation served primarily as a tool for assessing the entrepreneurial spirit within a company. Perera and Samarakoon (2021), for example, viewed entrepreneurial orientation as a strategic instrument used by entrepreneurs to identify and capitalize on market opportunities. It plays a crucial role in leveraging both existing and novel knowledge to exploit these opportunities effectively. Kiyabo and Isaga (2020) similarly defined entrepreneurial orientation as encompassing processes, practices, and decision-making activities that facilitate new market entries. Idruset *al.* (2020) expanded on this concept by suggesting that small and medium enterprises could achieve substantial growth and performance improvements by incorporating entrepreneurial orientation into their strategic planning as an entrepreneurial strategy. This approach aligns with the idea that entrepreneurial orientation is a business practice aimed at integrating entrepreneurial principles to ensure business success.

In a parallel study, Zaatoet *al.* (2020) characterized entrepreneurial orientation as the ability of entrepreneurial individuals or firms to identify and capitalize on opportunities through proactive measures, calculated risk-taking, and innovative initiatives, particularly in the

development and launch of new or innovative products and services aimed at outperforming competitors. These three dimensions of entrepreneurial orientation—innovativeness, proactiveness, and risk-taking—have consistently proven to be key indicators of business performance, providing an accurate assessment of whether businesses are succeeding or faltering.

Family businesses are characterized as enterprises owned and operated by one or more families across multiple generations, exhibiting a broad presence across various sectors and industries with diverse organizational structures, ranging from small-scale ventures to expansive conglomerates (Akinnuoye and Onuoha, 2023; Kyoveet *et al.*, 2021). According to Abun *et al.* (2022), a family business is defined by a situation where a family possesses more than 50% ownership stake in the company, and a majority of its managerial positions are held by family members who wield significant decision-making influence shaping the company's trajectory. This study perceives family businesses primarily in terms of ownership, where a minimum of two family members are actively involved in the management of the business. As such, it can be conceptualized as business enterprises that are wholly or partially owned, managed, and operated by families, with ownership possibly held by a single family member or distributed among multiple family members. Mariani *et al.* (2023) also consider family businesses as any organization where the founder maintains ownership stakes in the firm and holds a position on the board of directors, further highlighting the familial ties and influence within such enterprises.

Entrepreneurial Orientation Dimensions of Family Business Performance

Scholars have elaborated on the concept of Family Businesses (FBs) in terms of entrepreneurial orientation dimensions to provide a clearer understanding. Entrepreneurial orientation refers to an organization or individual's ability to think and act in an entrepreneurial manner, encompassing innovativeness, risk-taking, and proactiveness.

Innovativeness involves the propensity to pursue novel ideas, serving as a key driver of FB operations and performance. The capability for innovation plays a pivotal role in enhancing FBs' competitive advantages across various facets such as products, operations, marketing, human resources, and networking, both in domestic and international markets (Kwapisz *et al.*, 2022; Al Suwaidi *et al.*, 2021; Pourkianiet *et al.*, 2020). Risk-taking, on the other hand, signifies the willingness to take decisive action rather than adopting a cautious approach. It

reflects an entrepreneur's readiness to pursue opportunities despite uncertainties surrounding their success, involving bold actions without full knowledge of the potential outcomes (Fanajaet *al.*, 2023; Adim *et al.*, 2021; Adim and Poi, 2019). Proactiveness entails the ability to anticipate and capitalize on opportunities rather than merely reacting to them. Proactive organizations strive to maintain a competitive edge by leveraging new technologies, introducing innovative products or services, and staying ahead of industry trends. They seize opportunities and focus on creating new products or services, aligning with future customer needs and anticipating changes in demand or emerging challenges that translate into new business prospects (Okoli *et al.*, 2021; Anwar *et al.*, 2021; Bujan, 2020).

Previous literature has consistently highlighted the significant and positive impact of entrepreneurial orientation dimensions on family business performance. Fanajaet *al.* (2023) demonstrated that these dimensions are integral growth characteristics and strategic approaches used by entrepreneurs to enhance business performance. Furthermore, they are crucial elements in the decision-making process for entrepreneurs, whether they are initiating a new venture, exploring new markets, introducing innovative products, or restructuring an existing firm. Thus, it can be concluded that there exists a strong relationship between entrepreneurial orientation dimensions and the performance of FB firms, emphasizing the importance of these dimensions in driving business success and growth.

The Relationship Between Entrepreneurial Orientation and Family Business Performance

Entrepreneurial orientation plays a crucial role in shaping an organization's culture and ultimately contributes to its success. Recent research has highlighted a strong positive correlation between entrepreneurial orientation and the performance of family businesses, establishing entrepreneurial orientation as a fundamental and widely recognized determinant of family business success (Puumalainen *et al.*, 2023; Wales *et al.*, 2019). The culture within an organization significantly influences the performance of all its stakeholders, particularly employees. Therefore, adopting entrepreneurial orientation activities within an organization can yield significant benefits. Entrepreneurial orientation not only positively impacts organizational success but also enhances sales growth, which in turn contributes to overall organizational performance. The most commonly accepted theoretical framework for entrepreneurial orientation comprises three dimensions: innovativeness, proactiveness, and

risk-taking. Numerous studies have demonstrated the relationship between entrepreneurial orientation and family business performance, consistently showing that entrepreneurial orientation is associated with superior business performance.

Furthermore, in order for family business organizations to thrive and succeed, they must embrace an entrepreneurial orientation, as advocated by Beshret *al.* (2023). This strategic focus on identifying and pursuing new opportunities, coupled with a willingness to go beyond existing competencies and resources, is essential for the long-term sustainability and growth of family businesses. Against this backdrop, this study aims to explore the impact of entrepreneurial orientation on family business performance.

Empirical Literature

Abbas, Banu, and Ugheoke (2023) conducted a study to assess the impact of entrepreneurial orientation on business performance and to explore the key dimensions of entrepreneurial orientation from a strategic standpoint. Employing a qualitative approach, they reviewed literature on entrepreneurial orientation and business performance from Scopus and Google Scholar spanning the years 2010 to 2022, resulting in the selection of forty-three relevant papers. Their analysis provided an overview of the entrepreneurial orientation dimensions influencing business performance. The findings of the study underscored the critical importance of entrepreneurial orientation for the survival and sustainability of small and medium-sized enterprises (SMEs). Moreover, they revealed a significant relationship between business performance and the dimensions of proactiveness and innovativeness within entrepreneurial orientation.

Ojubanire and Idowu (2023) conducted a study to investigate the influence of entrepreneurial orientation dimensions on the performance of Small and Medium Enterprises (SMEs) in South-West Nigeria. They employed a questionnaire-based approach with purposive sampling, resulting in a sample size of 384 SMEs. Multiple regression techniques were utilized to analyze the data. The study's results revealed that proactiveness, competitive aggressiveness, risk-taking, and autonomy all exhibited positive regression coefficients, indicating a positive impact on business performance. However, innovativeness showed a negative regression coefficient, suggesting a less favorable impact on performance. The majority of SMEs identified proactiveness, competitive aggressiveness, profit-taking, and innovativeness as crucial components of entrepreneurial orientation, while a significant

portion tended to adopt a risk-averse approach. The findings indicated that most entrepreneurial orientation dimensions, except for innovativeness, had favorable effects on business performance. The study concluded that there is a significant positive relationship between entrepreneurial orientation and the business performance of SMEs. It emphasized the importance of promoting entrepreneurial competencies among employees by establishing supportive structures and rewarding entrepreneurial qualities within existing businesses. Additionally, the study highlighted the need for institutional support, such as substantial investments in infrastructural development, to create a conducive business environment that fosters innovation among SMEs.

Rachmawati and Suhartanti (2020) conducted a study aimed at assessing the direct impact of entrepreneurial orientation on family business performance in Indonesia, with a focus on the mediating role of family involvement. The study targeted a total population of 1,817 hotels, and utilizing the Slovin formula, a sample of 328 hotels in Yogyakarta was selected. The research employed questionnaires for data collection. Contrary to expectations, the findings indicated that entrepreneurial orientation alone did not have a significant effect on family business performance. However, family involvement emerged as a full mediator in the relationship between entrepreneurial orientation and family business performance. These results carry important implications for family businesses, offering insights into the development of strategies tailored for effective business management. The study introduces a novel model that delineates both the direct and indirect roles in assessing family business performance. In conclusion, the study underscores the potential of entrepreneurs with high entrepreneurial orientation to enhance business performance, highlighting the crucial role of active family involvement in business management. Moreover, the findings suggest that when the family is actively engaged in both ownership and management roles, it can significantly impact business performance and alleviate various business-related challenges.

Ibrahim and Martins (2020) investigated how entrepreneurial orientation (EO) dimensions affect firms' performance in Abuja. They adopted a quantitative methodology and devised a survey for data collection. Using simple random sampling, they gathered responses from 110 SMEs in the manufacturing and services sectors, with a final sample size of 97. Data analysis employed descriptive and inferential techniques. The results indicated that innovativeness, proactiveness, risk-taking, and competitive aggressiveness positively and significantly impact firms' performance. However, the relationship between autonomy and firm performance was

positive yet statistically insignificant. The study concluded that entrepreneurs can acquire entrepreneurial orientation skills and utilize them as enduring tools for competition and survival in their environment. It recommended that SMEs concentrate on the entrepreneurial orientation dimensions that are most effective in meeting their objectives, rather than adopting all dimensions indiscriminately

Table 1: Literature Mapping

S/N	AUTHOR	TOPIC	METHODOLOGY	FINDINGS & RECOMMENDATIONS	GAPS
1	Abbas <i>et al.</i> (2023).	Literature Study on Entrepreneurial Orientation and Firms Performance: An Assessment and Suggestions for Future Research	Qualitative approach and secondary data source were used from Scopus and Google Scholar.	Findings reveals that entrepreneurial orientation is essential for SMEs to survive and sustain their businesses.	The study relies on secondary data, restricted to 2010 & 2022 only. There was no theoretical backing.
2	Anwar <i>et al.</i> (2023).	Entrepreneurship in Family Firms: An Updated Bibliometric Overview.	Bibliometric methods, software, database and systematic review were employed in the study.	Result established that scholars should focus on S.E.W \$ agency theory as a theoretical foundation for importance and role of entrepreneurial motivation.	The study relies on secondary data. The study was limited to year 2010 and year 2021 only.
3	Beshret <i>al.</i> (2023).	Mediating Role of Empowering Workers in the Relationship Between the EO and Operational Performance of	The study used the descriptive analytical approach and questionnaire for collection of data from a non-probability sample.	Findings revealed a significant positive relationship between the EO and the operational performance of FBs.	limited to Bahraini FBs, and the Arabian Gulf. It does not include companies in other sectors.

		Bahraini Family Businesses.			
4	Gunawan and Koentjoro (2023).	Orchestration to Improve the Performance and Sustainability of Family Companies.	A qualitative positivist approach used.	findings show a link between conflict management strategies and increasing knowledge resources in resource orchestration to improve family enterprise sustainability.	The study is limited to one country (Indonesia). No theoretical backing
5	Saiyed <i>et al.</i> (2023).	Entrepreneurial Orientation, CEO Power and Firm Performance: An Upper Echelons Theory Perspective.	Panel data regression analysis used to test the hypotheses.	Results indicate that EO has an inverted U-shaped relationship with firm performance and that firms should have EO at a moderate level.	Geographically limited to one country (Indian). Concentrated on software firms only.
6	Rachmawati and Suhartanti (2020).	Effect of Entrepreneurial Orientation and Family Involvement on Family Business Performance: Case Study in Hotel Business in Yogyakarta.	convenience sampling method employed and questionnaire used for data collection. Hypotheses are tested by structural equation modeling using AMOS 22.0.	Findings reveal a significant implications that can help family businesses in developing strategies that are suitable in business management.	The study is limited to Yogyakarta in Indonesia.

Source; Authors review, (2024).

Theoretical Literature

Resource-Based View (RBV) theory, introduced by Edith Penrose in 1959, asserts that organizations should be assessed based on their available resources for achieving their goals. This theory emphasizes that organizations can attain and sustain high growth rates by acquiring resources that are valuable, rare, difficult to replicate, and unique. These resources

can be leveraged by firms through various means to establish enduring competitive advantages via both internal and external strategies. RBV is premised on the belief that an organization's resources and capabilities shape its performance and survival in its environment (Barney, 1991). Moreover, Miller (2019) posits that resources owned by firms differ across firms and are not readily transferable between them. These resources can be tangible (e.g., physical assets and financial capital), intangible (encompassing aspects like product quality, brand name, and brand image), and personnel-based (comprising technical expertise and knowledge assets) (Grant, 1991).

Russo and Fouts (1997) contend that an organization's capability plays a lateral role in achieving competitive advantage. This capability hinges on how the organization assembles, integrates, and deploys its tangible, intangible, and personnel-based resources to secure sustainable competitive advantage and ensure survival in a dynamic environment. RBV attributes the survival and performance of any enterprise to its resource possession and its capacity to harness these resources to maximize output in pursuit of its vision and mission. This perspective stresses that no enterprise can thrive without resources, but the ability to transform these resources into a competitive advantage is more strategic than mere acquisition and possession.

The RBV theory is important to this study as the dynamics in the FBs sector change over time, increased advancement especially in innovation and information technology brings about a corresponding competition in FBs activities. A firm's ability to compete may be determined by the resources that it has at its disposal. In conclusion, this study indicates that RBV can complement the development, sustainability, and performance of family businesses. RBV has garnered global acceptance due to its practical applications and advantages concerning family businesses performance. In this study, RBV (Barney, 1991) is adopted to provide theoretical base to study the relationship between entrepreneurial orientation and performance of family business in Nigeria.

Methodology

The study used a critical review of studies that link EO to FBs but it is limited to a conceptual, theoretical, and empirical review of EO and FBs studies. This study adopted the qualitative methodology in reviewing the relationship between entrepreneurial orientation and performance of family business in Nigeria in terms of how entrepreneurial orientation shape the survival, growth and performance of family business in Nigeria.

Result and Discussion

Family business is important to economic growth of the world but family business may not survive for the next generation if the right skills and capabilities are not met. Thus, this calls for deeper entrepreneurial activities that can contribute to improve family business performance in order to survive for the next generations and generations to come. In line with these assertions, the study conducted by Agbimet *et al.* (2022) shows that family member's involvement on the business performance is positive and significant, that business achieve better performance if family members are involved.

Conclusion and Recommendation

The family business has contributed greatly to economic activity of nations globally. Hence concluded that EO has significant implications that can help family businesses in developing strategies that are suitable in business management because EO occupies a strategic position in developing sustainable competitive advantage in the family business of the world. Family businesses need to be committed to innovation, proactivity, courage in taking risks and being able to manage risk. However, entrepreneurial strategy can lead to positive performance outcomes, an emphasis on EO can be challenging for family firms particularly in emerging economies such as Nigeria characterized by weak institutional environment.

Based on the theoretical and empirical review of various scholars, it is therefore, recommended that family business should innovate their services in providing an easy-to-use or friendly interface website to help consumers seamlessly. Risk-taking should be viewed as part of family culture necessary to engender returns on investment. Family business should always be pro-active to leverage on information communication and technology as it served as drag net to attract the world and boundless opportunities it has to offer. Future research may choose to use several types of family businesses so that more varied results can be obtained. Future research could also compare family businesses with non-family businesses.

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IMPACT OF ORGANISATIONAL CULTURE ON THE CRITICAL SUCCESS FACTORS FOR TOTAL QUALITY MANGAEMENT IN SMALL AND MEDIUM CONSTRUCTION FIRMS IN ABUJA, NIGERIA

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Abstract

One of the most important factors in running a business today is competition, most companies practice the 'new concept of quality, Total Quality Management (TQM), which is proactive in order to gain competitive advantage over their competitors. Unfortunately, the implementation of TQM among small and medium size construction firms (construction SMEs) is a challenge which results into poor performance in terms of cost, time and quality delivery of its products. Despite numerous researches on TQM implementation in SMEs and firm culture, there is a dearth of research on the impact of organisational culture on the critical success factors of TQM in Nigerian construction SMEs. In order to address this problem, the study assessed the impact of organisational culture on the critical success factors of TQM in construction SMEs in Kaduna State with a view to enhancing the performance of construction SMEs. The study adopted a quantitative research approach using the survey research design. Structured questionnaire was used to collect data from one hundred and thirty-five (135) professionals of construction SMEs in Kaduna State registered with Kaduna State Public Procurement Authority. The data collected were analysed with the use of Mean Item Score (MIS) and Spearman Rank correlation analysis. Findings from the study revealed that the most important attribute of organisational culture peculiar to construction SMEs is "Empowerment" (MIS = 4.23); the most important factor influencing the TQM capabilities of construction SMEs is "High job turnover rate" (MIS = 4.24); there exists a strong, positive and significant relationship between organisational culture on the critical success factors of TQM in construction SMEs ($r = 0.548$; $p = 0.000$); and the most effective strategy for fostering positive organisational culture for enhanced TQM capabilities amongst construction SMEs is "Organisations need to utilise organisational culture dynamically" (MIS = 4.28). The study therefore concludes that the impact of organisational culture on the critical success factors of TQM in construction SMEs is significant and capable of enhancing the performance of construction SMEs provided specific strategies are constantly implemented. It was recommended that the management of construction SMEs in Kaduna State should set up a mechanism for enhancing the performance of firms by using the strategies developed in this study as a basis.

Keywords: Construction SMEs, Critical success factors, National culture, Total Quality Management.

Introduction

Small and Medium Enterprises (SMEs) in Nigeria have continued to experience poor quality of products and services despite concerted efforts by governments and the private sector to improve their standards of operations (Igbadio and Asamber, 2021). Empirical research has tried to understand why there is consistent low level of quality products and services offered

by SMEs in Nigeria. The concept of quality is central in understanding the strategic perspective conceptualized as Total Quality Management (TQM). Therefore, the importance of the concept of quality has affected theoretical and empirical arguments on the need to adapt quality in all spheres of business life, which has led to the TQM (Igbadio and Asamber, 2021).

SMEs are important engines for growth in both developed and developing countries due to their role in generating employment and stimulating social cohesion, their flexibility and quick adaptability to change makes them essential to responding to the global business demands (Shah *et al.*, 2013). Despite the roles played by SMEs in the economies of developing countries, they are still lagging behind their counterparts in developed countries (Shah *et al.*, 2013). One of the most important factors in running a business today is competition, most companies practice the 'new' concept of quality, TQM, which is proactive in order to gain competitive advantage over their competitors. The principle of TQM works with a change in culture which is not easily achieved immediately but takes time to implement (Akpane *et al.*, 2014). According to Akpane *et al.* (2014), TQM is a managerial system widely implemented in the world as a cultural phenomenon, many firms failed in the introduction of TQM because their managers focused on the technical or managerial aspects of the system and neglected the most important aspect which is the cultural one. The implementation of TQM is a challenge because it requires a change in the manner that people within the firm think and act owing to the fact that a firm's organizational culture is affected by the national culture of the country (Akpane *et al.*, 2014). Despite numerous researches on TQM implementation in SMEs and firm culture, there is a dearth of research on the impact of organisational culture on the critical success factors of TQM in Nigerian construction SMEs which this research seeks to address.

In view of the above background, this study assessed the impact of organisational culture on the critical success factors of TQM in small and medium construction firms (construction SMEs) in Kaduna State, Nigeria with a view to enhancing the performance of construction SMEs. To achieve this aim, this study identified the attributes of organisational culture peculiar to construction SMEs; examined the critical factors influencing the TQM capabilities of construction SMEs; determined the impact of organisational culture on critical success factors of TQM in construction SMEs; and developed strategies for fostering positive organisational culture for enhanced TQM capabilities amongst construction SMEs.

Literature Review

Extant review of literature was undertaken to identify the key variables required to achieve the aim and objectives of the study and hence address the research problem. The following areas were therefore covered in this section.

Attributes of organisational culture peculiar to small and medium construction firms

The different attributes of culture have been arranged on basis of norms and attitudes which help in differentiating one firm from another (Awadh and Saad, 2013). The process of thinking helps in establishing one member from another on basis of cognitive thinking. The success guidance based upon different values and norm that makes culture effective. The set of beliefs, behaviours, norms and values helps in making culture most effective. The knowledge of culture has been gained through understanding and beliefs on basis of large groups. Therefore, culture in an organisation consists of the unspoken conventions, beliefs, and customs that determine how power, hierarchy, and decisions are made. It's a way of thinking, knowing, doing, and behaving in relation to a larger cultural context. Implicit, concealed, intrinsic, and formal knowledge of the organisation guide employee behaviour and determine the consequences for the business (Prasanna *et al.*, 2023).

Critical success factors influencing the TQM capabilities of small and medium construction firms

Organisational culture consists of the beliefs, values, norms, customs and practices of the organization (Mohammed and Rad, 2006). The concept is a system of norms, shared values, concerns, and common beliefs that are understood and accepted by the members of the organisation. The members of the organisation accept these as valid, follow them and teach them to incoming members as a pattern to be followed for problem solving and as required thinking style and behaviour. The organisational culture is defined as “the collaborative process of creating shared awareness and understanding out of different individuals’ to help and orient its members to “reality” in ways that provide a basis for alignment of purpose and shared action (Morelli and Wang, 2020). Morelli and Wang (2020) further described that “the pattern of such collective behaviours and assumptions that are taught to new organisational members as a way of perceiving and, even thinking and feeling. In all, this jointly shared description turns to create a unique social and cultural environment within the group, which later, if it succeeds, manages to direct what an individual employee normally

behaves based on a sense of collective values, beliefs and principles, as the so-called group's styles, visions, and norms. Based on this line of thought. Sakhrekar (2020) reported that organisational culture is the major focus of organisational behaviour because of its effect on overall performance of the organisation.

Impact of organisational culture on critical success factors of TQM in small and medium construction firms

Organisational culture is essential for success inside a business. It is a standard indicator of how content and inspired your staff is in their tasks, as well as how stable your company claims to be. A stable, efficient, friendly, encouraging, and career-oriented workplace is crucial for the development, management, and maintenance of productive and competent employees, but businesses must be aware of this fact (Adewunmi *et al.*, 2011). There is a relationship between an organisation's culture, employee performance, and employee engagement. Corporate culture may affect productivity because of its effect on employees' willingness to be truthful at work. According to Eniola *et al.* (2019), while some empirical studies have shown that TQM and organisational performance are positively related (Al-Dhaafriet *al.*, 2016; Ibidunniet *al.*, 2017; Panuwatwanichet *al.*, 2017), others (Duarte *et al.*, 2011; Su *et al.*, 2008), found no effect of TQM on organisational performance. Some studies even found a negative relationship between TQM and business performance. The main reasons for these different results may include use of different TQM measures, measures of different performance, a lack of training and support of management and ineffective application, as well as being conducted in different contexts or countries (Kaynak, 2003; Nair, 2006). However, many studies have shown a correlation between a company's culture and its workers' efficiency, effectiveness, and creativity on the job (Shayah and Zehou, 2019; Morelli and Wang, 2020; Coelho *et al.*, 2022; Prasanna *et al.*, 2023).

Strategies for fostering positive organisational culture for enhanced TQM capabilities amongst small and medium construction firms

Studies have identified various strategies for fostering positive organisational culture amongst construction firms by critically exploring the organisational culture and its impact on employee job performance (Ibrahim and Tsado, 2022). Based on this, Mileva and Hristova (2022) reported that it is important for organisations to invest in employee well-being through different forms of training and workshops. To achieve this, Mileva and Hristova (2022)

suggested further that leaders should work on building self-confidence, fostering competition among employees, encouraging relationships with the external world, and sharing expertise and knowledge among the organisational members.

Research Methodology

The quantitative research approach was adopted for this study. In view of this, this study used structured questionnaire to collect data from 135 professionals of small and medium construction firms in Kaduna State registered with Kaduna State Public Procurement Authority (KADPPA). The sampling frame of the study was made up of list professionals in small and medium construction firms in Kaduna State registered with KADPPA among which are Architects, Builders, Civil Engineers, Services Engineers and Quantity Surveyors. analysis of data was undertaken with the use of descriptive statistics such as percentage, frequency counts and Mean Item Score (MIS); and inferential statistics such as correlation analysis. Frequency counts and percentage were used to analyse the profile of respondents while MIS and correlation analysis were used to analyse data regarding the research objectives. MIS is being ranked from 1.00 to 5.00 and the decision rule adopted for the MIS analysis are summarized in Table 1. The formula used for calculating MIS for data analysis is expressed in Equations 1 as follows:

$$MIS = \frac{\sum W}{N} \text{-----} (1)$$

Where: Σ = Summation, W = Weight, and N = Total

Table 1: Decision Rule for MIS Analysis

Scale	MIS Cut-Off Point	Interpretation			
		<i>Level of Importance</i>	<i>Level of Significance</i>	<i>Level of Effectiveness</i>	<i>of</i>
5	4.01 - 5.00	Extremely	Extremely	Extremely	
		Important	Significant	Effective	
4	3.01 - 4.00	Very Important	Very Significant	Very Effective	
3	2.01 - 3.00	Important	Significant	Effective	

2	1.01 - 2.00	Less Important	Less Significant	Less Effective
1	0.01 - 1.00	Least Important	Least Significant	Least Effective

Source: Adapted and Modified from Shittu *et al.* (2021); Shittu *et al.* (2022)

For the Spearman Rank correlation, the decision rules for the nature of correlation state that if coefficient of correlation (r) = 0.10 to 0.29, then there is small amount of correlation; if r = 0.30 to 0.49, then there is medium amount of correlation; and if r = 0.50 - 1.0, then there is large amount of correlation between the variables, as opined by Pallant (2013).

Results and Discussion

Analysis of respondents' profile

In the field work of this study, 135 copies of questionnaires were distributed to construction professionals of which 115 copies were retrieved and used for analysis. This gives a response rate of 85%. The profile of these construction professionals considered for the study is presented in Table 2. It was shown in Table 2 that the total population considered includes a mix of all the required professionals engaged in road construction works. Table 2 also shows that the respondents are educated enough to understand the questions being asked and provide reliable data needed for the study. It was also shown in Table 2 that all respondents are qualified to take part in the survey. Table 2 indicates that the professionals are experienced enough to provide reliable data required for this study. On the number of TQM and related technologies handled by respondents, it was shown that the professionals have the requisite experience to be able to provide reliable data needed for this study.

Table 2: Respondents' Profile

PROFILE	STATISTICS	
Respondents' Profession	Frequency	Proportion (%)
Architect	20	17

Builder	39	34
Civil Engineer	11	10
Services Engineer	8	7
Quantity Surveyor	32	28
Others	5	4
Respondents' Highest Academic Qualification	Frequency	Proportion (%)
National Diploma (ND)	15	13
Higher National Diploma (HND)	39	34
Bachelor's Degree (BSc/BTech)	33	29
Master's Degree (MSc/MTech)	28	24
Doctoral Degree (PhD)	0	0
Respondents' Professional Qualification	Frequency	Proportion (%)
MNIA/ARCON	19	17
MNIOB/CORBON	31	27
MNSE/COREN	16	14
MNIQS/QSRBN	20	17
Others	29	25
Respondents' Years of Experience	Frequency	Proportion (%)
1-5 Years	40	35
6-10 Years	28	24
11-15 Years	19	17

16-20 Years	17	15
Above 20 Years	11	10
No. TQM and Related Technologies Handled by Respondents	Frequency	Proportion (%)
None	13	11
1 - 5	64	56
6 - 10	20	17
11 - 15	11	10
Above 15	7	6
TOTAL	115	100

Assessment of the attributes of organisational culture peculiar to construction SMEs

The use of Mean Item Score (MIS) was adopted to rank the perception of respondents on the importance of the attributes of organisational culture peculiar to construction SMEs in Kaduna State. The results of the MIS analysis reveals that the most important attribute of organisational culture peculiar to small and medium construction firms is “Empowerment” (MIS = 4.23), while the least important attribute of organisational culture peculiar to construction SMEs is “Hierarchy” (MIS = 2.29). On the average, all the identified the attributes of organisational culture peculiar to construction SMEs in Kaduna State are very important (average MIS = 3.58). The summary of the results of the attributes of organisational culture peculiar to small and construction SMEs in Kaduna State is presented in Table 3.

Table 3: Attributes of Organisational Culture Peculiar to Construction SMEs

Code	Attributes of Organisational Culture	MIS	Rank	Decision
No.	Peculiar to Construction SMEs			

B9	Empowerment	4.23	1st	Extremely Important
B15	Customer focus	4.18	2nd	Extremely Important
B14	Creating change	4.15	3rd	Extremely Important
B27	Pragmatic – Normative	4.15	4th	Extremely Important
B16	Organisational learning	4.01	5th	Extremely Important
B4	Core values	4.00	6th	Very Important
B5	Involvement	3.88	7th	Very Important
B18	Goals and objective	3.84	8th	Very Important
B20	Clan	3.83	9th	Very Important
B7	Adaptability	3.83	9th	Very Important
B23	Process – Results	3.72	11th	Very Important
B1	Beliefs	3.71	12th	Very Important
B3	Norms	3.71	12th	Very Important
B2	Behaviours	3.69	14th	Very Important
B6	Consistency	3.63	15th	Very Important
B11	Capability development	3.63	15th	Very Important
B26	Tight – Loose Control	3.63	17th	Very Important
B19	Adhocracy	3.61	18th	Very Important
B12	Agreement	3.42	19th	Very Important

B22	Market cultures	3.30	20th	Very Important
B24	Job – Employee Orientation	3.26	21st	Very Important
B25	Open – Closed System	3.11	22nd	Very Important
B13	Coordination and integration	3.05	23rd	Very Important
B10	Team orientation	3.02	24th	Very Important
B17	Strategic direction and intent	2.91	25th	Important
B8	Mission	2.83	26th	Important
B21	Hierarchy	2.29	27th	Important
Average MIS		3.58		Very Important

The result in this section agrees with findings from previous studies. For instance, it has been established that organisational culture contributes to the success of an enterprise by encouraging employees to value the same things and work together and it also guides employee behaviour and determine the consequences for the business (Awadh and Saad, 2013; Prasanna *et al.*, 2023).

Examination of the critical factors influencing the TQM capabilities of construction SMEs

Table 4 revealed that the most important factor influencing the TQM capabilities of construction SMEs is “High job turnover rate” (MIS = 4.24), while the least important factor influencing the TQM capabilities of construction SMEs is “Shareholders and owners” (MIS = 2.03). On the average, all the identified factors influencing the TQM capabilities of construction SMEs in Kaduna State are very important (average MIS = 3.77).

Table 4: Critical Factors Influencing the TQM Capabilities of Construction SMEs

Code	Critical Factors Influencing the	MIS	Rank	Decision
No.	TQM Capabilities of Construction SMEs			
C10	High job turnover rate	4.24	1st	Extremely Important

C27	Quality and excellence	4.23	2nd	Extremely Important
C16	Accumulated knowledge	4.20	3rd	Extremely Important
C21	Management/leadership	4.17	4th	Extremely Important
C23	Strength and stability	4.16	5th	Extremely Important
C15	Human capital	4.01	6th	Extremely Important
C18	Organisational resources	3.99	7th	Very Important
C32	Integrity and ethics	3.99	7th	Very Important
C17	Material and financial resources	3.97	9th	Very Important
C29	Customer satisfaction	3.97	9th	Very Important
C12	Flexibility	3.96	11th	Very Important
C5	Individualism	3.94	12th	Very Important
C6	Uncertainty avoidance	3.94	12th	Very Important
C25	Profitability and growth	3.94	12th	Very Important
C3	Culture	3.93	15th	Very Important
C31	Corporate identity and image	3.93	16th	Very Important
C13	Openness	3.89	17th	Very Important
C20	Work environment	3.89	17th	Very Important
C19	Training and development	3.85	19th	Very Important
C28	Teamwork	3.77	20th	Very Important
C8	Organisational performance quality	3.75	21st	Very Important
C7	Masculinity	3.74	22nd	Very Important
C14	Responsiveness	3.66	23rd	Very Important
C2	Attitudes	3.65	24th	Very Important

C1	Values		3.64	25th	Very Important
C30	Engaged employees and empowerment		3.63	26th	Very Important
C11	Support for involvement and adaptability		3.62	27th	Very Important
C26	Respect and trust		3.56	28th	Very Important
C9	Organisational citizenship		3.27	29th	Very Important
C4	Power distance		3.13	30th	Very Important
C24	Social responsibility and corporate citizenship		2.92	31st	Important
C22	Shareholders and owners		2.03	32nd	Important
Average MIS			3.77		Very Important

The findings of past studies are in line with the finding of this study in this area. Past studies found that the critical success factors having influence on organisational culture is a major variance-causing factor in TQM implementation programs that inhibits or allows the success of such a program. Therefore, these success factors are cultural variables that drive TQM success (Mohammed and Rad, 2006).

Determination of the impact of organisational culture on critical success factors of TQM in construction SMEs

In order to determine the impact of organisational culture on critical success factors of TQM in construction SMEs in Kaduna State, two types of analyses were undertaken. Firstly, the use of MIS was adopted to rank the perception of respondents on the impact of organisational culture on critical success factors of TQM in construction SMEs. Secondly, the use of Spearman Rank correlation analysis was adopted to determine the relationship between organisational culture and critical success factors of TQM in construction SMEs. However, before conducting the Spearman Rank correlation analysis, the suitability of the data for Spearman Rank correlation was tested.

The results of the MIS analysis on the impact of organisational culture on critical success factors of TQM in small and medium construction firms, shown in Table 5, indicates that the most significant impacts of organisational culture on critical success factors of TQM in construction SMEs are “Organisational culture is essential for innovative success inside a business”, “Organisational culture directs the behaviours and decision-making abilities of employees”, and “The extent to which an employee feels respected, valued, and supported by their employer” (MIS = 4.23 respectively). The least significant impact of organisational culture on critical success factors of TQM in construction SMEs is that “It is a standard indicator of how content and inspired employees are in their tasks” (MIS = 3.05). On the average, all the identified impacts of organisational culture on critical success factors of TQM in construction SMEs in Kaduna State are very significant (average MIS = 3.90). The summary of results for this analysis is presented in Table 5.

Table 5: Impact of Organisational Culture on the Critical Success Factors of TQM in Construction SMEs

Code No.	Impact of Organisational Culture on the Critical Success Factors of TQM in Construction SMEs	MIS	Rank	Decision
D1	Organisational culture is essential for innovative success inside a business	4.23	1st	Extremely Significant
D16	Organisational culture directs the behaviours and decision-making abilities of employees	4.23	1st	Extremely Significant
D6	The extent to which an employee feels respected, valued, and supported by their employer directly impacts their productivity	4.23	1st	Extremely Significant
D17	Organisational culture also generates its impact on organisational structure both through its design and its implementation	4.23	1st	Extremely Significant

D8	Distinguishing one organisation from another	4.17	5th	Extremely Significant
D9	Providing employees with a sense of belonging	4.15	6th	Extremely Significant
D7	Company's culture determines the survival tactics that encourage individual success and group cohesion	3.97	7th	Very Significant
D15	Organisational culture stimulates innovative behaviour among members of the organisation	3.96	8th	Very Significant
D18	Adhocracy culture has a positive impact on TQM	3.95	9th	Very Significant
D12	Organisational cultures are in charge of everything that makes the organisation function	3.93	10th	Very Significant
D4	Employees are more driven to excel when the company has the culture it wants	3.90	11th	Very Significant
D14	The company's performance is directly proportional to the efficiency of its staff	3.90	11th	Very Significant
D10	Encouraging the development of loyalty to goals beyond personal gain	3.81	13th	Very Significant
D3	It is a standard indicator of how stable your company claims to be	3.70	14th	Very Significant
D11	Serving as a unifying force within the organisation by establishing expectations for behaviour	3.68	15th	Very Significant

D5	It promotes cooperative working relationships between employees and management that are based on trust rather than legal obligations	3.64	16th	Very Significant
D13	Organisational cultures check to see whether the business is still operational	3.40	17th	Very Significant
D2	It is a standard indicator of how content and inspired employees are in their tasks	3.05	18th	Very Significant
Average MIS		3.90	Very Significant	

The reliability test carried out between the organisational culture on the critical success factors of TQM in construction SMEs in Kaduna State shows no evidence of outliers with a scatterplot with the data points spread all over the place, suggesting a very high correlation. This shows that the data set is fit for Spearman Rank correlation analysis. Figure 1 shows the graph of the scree plot of the relationship between organisational culture on the critical success factors of TQM in construction SMEs.

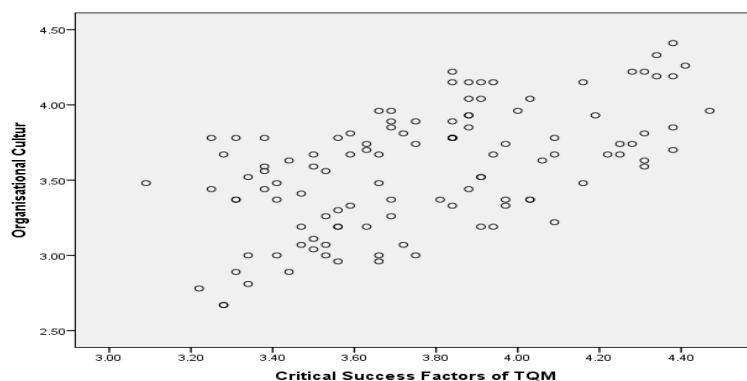


Figure 1: Scree Plot between Organisational Culture on the Critical Success Factors of TQM in Construction SMEs

The results of the Spearman Rank correlation analysis indicate that there exists a strong, positive and significant relationship between organisational culture on the critical success

factors of TQM in construction SMEs. The positive correlation indicates that improvement in the organisational culture of construction SMEs will result in the improvement in the success rate of the critical success factors of TQM in construction SMEs. The correlation coefficient (r value) observed was 0.548 indicating strong degree of association between the variables. Hence, the correlation between the variables is large (Pallant, 2013). The probability (P_{value}) value of 0.000 observed was less than the level of significance adopted for the study (0.01). This implies a significant relationship between the variables. The results of the Spearman Rank correlation analysis are summarised in Table 6.

Table 6: Relationship between Organisational Culture and Critical Success Factors of TQM in Construction SMEs

VARIABLES		OBSERVATIONS		INFERENCES		
X_1	X_2	r (%)	LOS	P_{value}	Strength of Relationship	Remark
Organisational Culture	Critical Success Factors of TQM	0.548	0.01	0.000	Strong	SS

KEY:

SS = Statistically Significant

r = Correlation Coefficient

LOS = Study's Level of Significance

P_{value} = Calculated Probability Value

The study of Adewunmi *et al.* (2011) agrees with the finding of this study here. This is because Adewunmi *et al.* (2011) found that there is a relationship between an organisation's culture, employee performance, and employee engagement.

Development of strategies for fostering positive organisational culture for enhanced TQM capabilities amongst construction SMEs

It was revealed in Table 7 that the most effective strategy for fostering positive organisational culture for enhanced TQM capabilities amongst construction SMEs is "To foster successful

TQM implementation and integration, organisations need to utilise organisational culture dynamically” (MIS = 4.28), while the least effective strategy for fostering positive organisational culture for enhanced TQM capabilities amongst construction SMEs is “Organisations should focus more on democratic behavioural approach” (MIS = 2.03). On the average, all the identified strategies for fostering positive organisational culture for enhanced TQM capabilities amongst construction SMEs in Kaduna State are very effective (average MIS = 3.82).

Table 7: Strategies for Fostering Positive Organisational Culture for Enhanced TQM Capabilities Amongst Construction SMEs

Code No.	Strategies for Fostering Positive Organisational Culture	MIS	Rank	Decision
E7	To foster successful TQM implementation and integration, organisations need to utilise organisational culture dynamically	4.28	1st	Extremely Effective
E3	Motivate employees to accept organisational values and goals	4.27	2nd	Extremely Effective
E4	Motivate employees to do the best they can for the benefit of the organisation	4.27	2nd	Extremely Effective
E20	Organisations should focus more on employee empowerment and engagement	4.27	2nd	Extremely Effective
E6	Firms should foster an effective and stable organisational culture that the workforce can respect	4.17	5th	Extremely Effective
E9	Organisations should invest in employee well-being through different forms of training and workshops	4.16	6th	Extremely Effective
E11	Leaders should foster competition among employees	4.00	7th	Very Effective
E2	Create positive attitudes towards the organisation	3.99	8th	Very Effective

E13	Leaders should share expertise and knowledge	3.98	9th	Very Effective
E1	Create satisfaction in their employees	3.97	10th	Very Effective
E17	Organisations should focus more on timely accomplishment of intended employee performance	3.97	10th	Very Effective
E12	Leaders should encourage relationships with the external world,	3.96	12th	Very Effective
E22	Enhancing flexible and many work environments	3.96	13th	Very Effective
E23	Create employees' access to learning and innovation opportunities	3.95	14th	Very Effective
E10	Leaders should build self-confidence among the organisational members	3.85	15th	Very Effective
E16	Organisations should focus more on achieving company mission's goal	3.79	16th	Very Effective
E18	Organisations should focus more on promoting a socially moral workplace	3.68	17th	Very Effective
E8	Organisations need to possess the ability to systematically identify and assess their organisational culture through a well-established framework	3.66	18th	Very Effective
E14	Management of construction firms should practice leadership qualities that promotes company productivity and profitability	3.61	19th	Very Effective
E15	Organisations should focus more on good employer-employee's relationships	3.50	20th	Very Effective

E5	Promote employees' intention to stay as active members of the organisation	3.44	21st	Very Effective
E21	Organisations should focus more on teamwork	3.18	22nd	Very Effective
E19	Organisations should focus more on democratic behavioural approach	2.03	23rd	Effective
Average MIS		3.82		Very Effective

Findings from previous studies are in line with the findings here. For instance, Ibrahim and Tsado (2022) reported that in order to foster positive organisational culture by construction firms, construction managers in related sectors should be aware of the leadership qualities they display since it has been demonstrated that an organisation's culture is a reflection of the examples it sets, which ultimately decides if the culture produced is one that promotes company productivity and profitability.

Conclusion and Recommendation

Findings from the study revealed that the most important attribute of organisational culture peculiar to construction SMEs is “Empowerment”. It was also shown that the most important factor influencing the TQM capabilities of construction SMEs is “High job turnover rate”. It was also shown that there exists a strong, positive and significant relationship between organisational culture on the critical success factors of TQM in construction SMEs. Finally, results of data analysis revealed that the most effective strategy for fostering positive organisational culture for enhanced TQM capabilities amongst construction SMEs is “To foster successful TQM implementation and integration, organisations need to utilise organisational culture dynamically”. The study therefore concludes that the impact of organisational culture on the critical success factors of TQM in construction SMEs in Kaduna State is significant and capable of enhancing the performance of construction SMEs provided specific strategies are constantly implemented.

In view of the conclusions of the study, it is recommended that management of construction SMEs should always ensure that the organisation achieves an organisational culture that is essential for innovative success inside a business; an organisational culture that directs the behaviours and decision-making abilities of employees; and measures that enables an employee to feel respected, valued, and supported. This will assist to foster positive organisational culture in a firm. It is also recommended that the management of construction SMEs should set up a mechanism for enhancing the performance of the firms by using the strategies developed in this study, especially, the strategy for fostering successful TQM implementation and integration by utilising organisational culture dynamically, as a basis.

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EMERGENCY VEHICLES SIREN SIGNAL ENHANCEMENT USING ADAPTIVE LOWPASS FILTER

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ABSTRACT

The advancement achieved in the area of automotive design improves both comfort and quality of driving. The anti-acoustic insulation used in modern cars for outside noise protection, coupled with the traffic noise makes the emergency vehicle siren sounds to get muffled, leaving the motorists unaware to the emergency vehicles within the vicinity. Consequently, there is a need to enhance the signal using low-pass filter for noise cancellation. The ambulance siren signal was foremost recorded by the onboard mic which was then processed in MATLAB utilizing sound signal processing modules. The first three values of the system's unit sample response were determined using MATLAB as well as manual calculation and the results were compared. Pole and zeros were determined for the system characteristics and stability. The designed low-pass filter reduced the amplitude of the input signal ranges (- 0.1v to + 0.1v) to (- 0.049v to + 0.049v). Hence, this indicates that the system (filter) removed all the higher frequencies and some unwanted signal thus noise. Therefore, the system output can be considered as smooth and enhanced acoustic signal. The Artificial Neural Network (ANN) analysis predicted an averagely very high accuracy.

Keywords: Acoustic signal, low-pass filter, Ambulance, Artificial Neural Network and frequency response.

1.0 Introduction

Emergency vehicles are normally driven using warning lights and vulgar noise production devices (sirens). This is to alert the motorists and also the pedestrians about its approach, for the motorist or pedestrian to clear the path for the emergency vehicle. The flashing lights on the emergency vehicle are only effective if the motorist has already directly sighted the lights on the vehicle or from a reflection. The warning sirens on the other hand are the only means that a motorist or pedestrian is notified of its approach, without even sighting the vehicle, and hence this warning mechanism is important for the prevention of collisions (Howard and Elefrerions 2011). Therefore, the Ambulance siren can be considered among one of the contributing factors that need to be studied and improved, if possible, which is the main aim of this research.

1.1 Acoustic Wave

Emergency vehicles' acoustic sirens are an irritating part of the sound-scape in the town areas, predominantly those produced by fire units and hospital ambulances since they tend to be

grouped around fire departments and hospitals unsettling the same population most of the time (Balastegui et al. 2013). Acoustic waves are basically defined as the disturbances which involved mechanical vibrations in three states of matter (solids, liquids, or gases) (Gregory 1999).

1.2 Nature of Acoustic Wave

The acoustic wave component is defined by several factors, and the utmost applicable factors can be determined using physical and acoustical evaluation and observations. These comprise sound time, absorption, and echoes (Mark and Jens 2009). Acoustic waves (signals) are waves that solidly depend on the elasticity of a medium in which its frequencies range from zero to some few terahertz ($1\text{THz} - 10^{12}\text{Hz}$) (James 1998).

1.3 Production of Acoustic Wave

Acoustic propagation is normally characterized by three (3) major factors: (i) attenuation in direct proportion with signal frequency, (ii) multipath and time-varying propagation, and (iii) sound speed of approximately (1500 m/s) (Cantarini et al., 2021). The main background noise, although often considered Gaussian, is not white, nevertheless observed to have a decaying power spectral density. Acoustic propagation is generally supported at lower frequencies and bandwidth (10 and 15 kHz). (Milica and James 2009).

2.0 Literature Review

(Meucci, et al., 2008) conducted research on the development of a small, inexpensive Atmel microcontroller-based siren detection system with the capacity to discriminate the siren sound relating to other sound sources within the traffic. (Fatima, et al., 2020) the proposed system uses audio sensors to record the siren sound and pre-process the acquired signal using a bandpass filter. (Supreeth et al., 2008) developed a system that segregates the Ambulance siren sound from noisy signals in the frequency domain. Identification of ambulance sounds in busy traffic is a challenging task. (Canterini, et al., 2021) implemented an Emergency Vehicle Detection System (EVDS), with a Convolutional Neural Network-based deep learning model. (Pramanick, et al., 2021), developed an efficient and simple architecture for siren recognition and city sound identification utilizing different sound-to-image transformation approaches viz: Mel-spectrogram, Scalogram, and Fourier decomposition method (FDM).

2.1 Problem Statement

The review of related works revealed that, many research works were conducted to mitigate the effects of traffic and other unwanted signals (Noise) on the emergency vehicles' siren signal. Furthermore, nowadays, the design of cars with comfort has improved the quality of driving. The anti-acoustic insulation used in modern cars for outside noise protection, coupled with the traffic noise makes the emergency vehicle siren sounds to get muffled. Consequently, rendered the motorists unaware to the emergency vehicles within the vicinity. Identification of ambulance sounds in busy traffic is a challenging task. Therefore, there is a need to identify the ambulance siren sound amidst a noisy environment.

3.0 Methodology

3.1 System Design and Analysis

A system is any device or algorithm that generates an output signal $y(n)$ in response to an input signal $x(n)$ (Fatimah et al., 2020). In general, the system is defined by the type of operation that it performs on the signal. If the operation is linear, the system is called linear. If the operation is non-linear the system is called non-linear, such operations are usually referred to as signal processing. To remove the noise in an electrocardiogram or remove echoes in an audio signal (Smith, 2011). This research is to design a system that will perform or process an acoustic signal of an emergency siren.

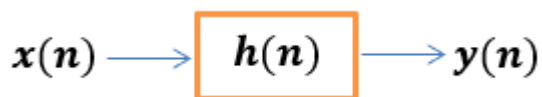


Figure 1: System Input-Output

The system's frequency response (magnitude and phase)

Filters are the circuit that permits the frequencies in one range to pass, while obstructing the frequencies in all other or different extents. There are different types of filters which include Low Pass, High-Pass and Band Pass filters (Cantarini et al., 2021). As the name implies a Low-Pass filter allows low-frequency signals and blocks high-frequency signals. High-Pass filter allows high-frequency signals only and blocks otherwise. Band-Pass filter allows signals whose frequency is within a specific frequency band. Filters are essential segments of electronic and communication systems. It can also be used to minimize or cancel out noise signals (Shashank, 2012). The **Butterworth Filter** approximation function is referred to a frequency response that is maximally flat (less ripples) response. This is due to the fact that, the pass-band is designed to achieve an excellent frequency response. This is expected from

0Hz until the cut-off frequency at -3dB with absent of ripples, higher frequencies beyond the cut-off point.

3.3 Manual Calculation to Obtained First Three Values

Manual calculations were first considered to obtain the first three values using equation (2)

$$y(-1) = y(-2) = y(n-3) = x(-1) = x(-2) = x(-3) = 0 \dots \dots \dots (2)$$

which simply means the system is a unit sample and define as below, because is zero at all values accept when $n = 0$, for the unit sample input $x(n) = \delta(n)$, which define below;

$$\begin{aligned} x(n) &= \delta(n) \\ &= \begin{cases} 1, & n = 0 \\ 0, & n \neq 0 \end{cases} \dots \dots \dots (3) \end{aligned}$$

Making the $y(n)$ subject of equation (i), the equation can be expressed as in equation (3)

$$\begin{aligned} y(n) = h(n) &= b_0x(n) + b_1x(n-1) + b_2x(n-2) + b_3x(n-3) - a_1y(n-1) \\ &\quad + a_2y(n-2) + a_3y(n-3) \dots \dots \dots (4) \end{aligned}$$

Where, $a_0 = 1.000$ and $n = 0, 1, 2, \dots$

3.4 The system transfer function

This function is handy for the analysis of filter design concerning its input and output signal characteristics. Therefore, the transfer function can be defined as the ratio of the system's input signal to that of the output signal, it has been seen that the system in question is a Linear Time-Invariant (LTI) system. Therefore, the transfer function of an LTI system is the Z-transform of its impulse response. It can be better illustrated by mathematical representation as follows:

$$\begin{aligned} H(Z) &= \frac{Y(Z)}{X(Z)} \\ &= \frac{\sum_{k=0}^L b_k Z^{-k}}{1 - \sum_{k=1}^N a_k Z^{-k}} \dots \dots \dots (4) \end{aligned}$$

3.5 Frequency response

Frequency response of any device describe its characteristics over a specified range of frequencies by simply showing how its gain or amount of signal its lets to pass through changes with frequency, the frequency response can be define as $H(e^{-j\theta}) = H(Z)$, by substituting $z = e^{-j\theta}$. (Pramanick et al., 2021)

The value of θ which is otherwise referred to as discrete frequency or normalised frequency whose unit is in radian, can be calculated by using the following formula.

$$\theta = \frac{2\pi f_c}{f_s} \dots \dots \dots (5)$$

3.6 Poles and Zeros Analysis

The characteristic of every digital filter normally specified by its pole and zeros together with a gain factor (Supreethet *al.*, 2020). This section analyzed the pole-zero of the filter to obtain some useful information about the filter's response, and also for the basis of digital filter design. The information obtained was also used to check the filter stability by finding the reflection coefficients.

4.0 Result and Discussion

4.1 System Coefficients

Matlab function (impz) was utilized to obtain the first three values of the system's unit sample response. The input coefficients of the system are represented by $A=[1 \ -2.7153 \ 2.4697 \ -0.7519]$. Similarly, that of the system's output coefficients represented by $B=[0.3151e-3 \ 0.9452e-3 \ 0.9452e-3 \ 0.3151e-3]$. The first three values obtained from Matlab operation are $[0.0003, \ 0.0018, \ 0.0051]$, and the plot of input coefficients against output coefficients is shown in the figure 2.

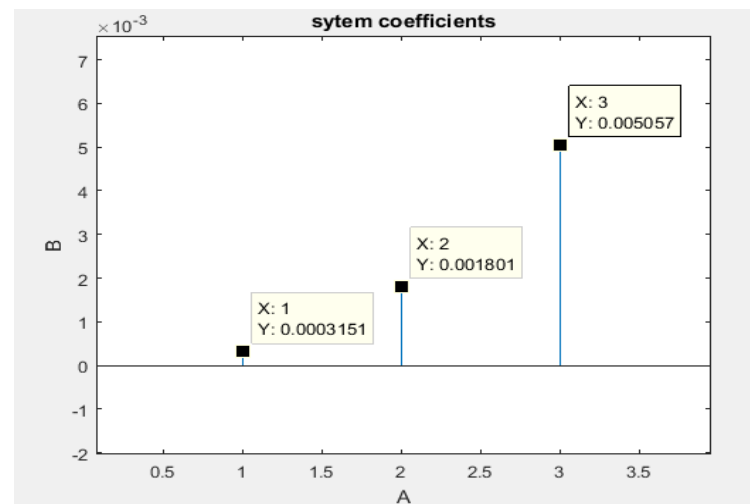


Figure 2: System Input and Output Coefficients

Table 1 compares MATLAB results with that of manual computations of the first three values of the system coefficients.

Table 1: Matlab and Manual Computational Values of System Response

Values of (n)	y(n)Result Using Matlab (computation)	y(n)Result Using Manual (computation)
0	0.0003	0.3151×10^{-3}
1	0.0018	1.8008×10^{-3}
2	0.0051	5.0567×10^{-3}
3	0.0098	9.8351×10^{-3}

The MATLAB results in comparison with the manual calculation are much similar and the difference is insignificant. The minor difference is as a result of **Butterworth Filter** approximation function. As the MATLAB result is rounded-up to four (4) decimal places and that of manual calculations is to 8 decimal places.

4.2 The system's frequency response (magnitude and phase)

The magnitude of the frequency response was obtained from the calculated results by means of the "freqz" function, the MATLAB. Furthermore, the function "abs" that stands for absolute was also included. Consequently, the phase was plotted with the help of the function "angle(H)" as demonstrated in Figure 4:

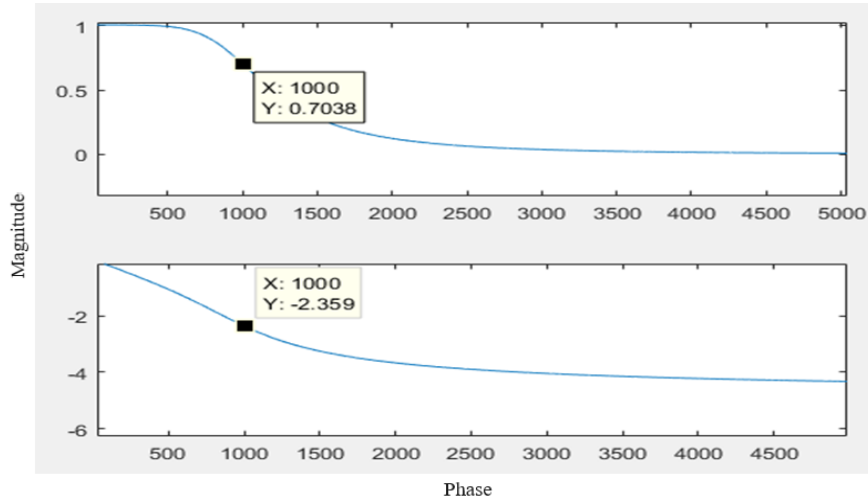


Figure 3: System's Frequency Response (Magnitude And Phase)

Figure 3 is the representation of 3rd order Butterworth low-pass filter, in which at cut-off frequency $f_c = 1000\text{Hz}$ and the corresponding magnitude is 0.7038. The phase magnitude of -2.359 at same cut-off frequency was realized. The information obtained from Figure 3 was used to evaluate the attenuation both magnitude and phase as:

$$dB = -20 \log_{10} \frac{V_{out}}{V_{in}} = -20 \log_{10} 0.7038 = -3dB$$

For that of phase is given by;

$$x = \frac{R \times 180}{\pi} = \frac{-2.359 \times 180}{180} = -135dB$$

4.3 Frequency response

Frequency response of a given system normally pronounced the system characteristics over a definite range of frequencies. This shows how its gain or amount of signal pass through changes with frequency. The frequency response defined as:

$$H(e^{-j\theta}) = H(Z)$$

where $z = e^{-j\theta}$.

The value of θ which is known as discrete or normalised frequency was calculated (in radian) using equation (5) (Rachel, *et al.*, 2020).

$$f_c(\text{Cut - Off frequency}) = 1000\text{Hz}, f_s(\text{Sampling frequency}) = 44100\text{Hz}$$

$$\theta = \frac{2\pi \times 1000}{44100} = 0.045\pi \text{ rad}$$

4.4 Magnitude and Phase

Magnitude and phase of the system was also analyzed using equation (4). However, using Euler's equation was easier as $e^{-j\theta}$, therefore simplified as follows:

$e^{\pm j\theta} = \cos \theta \pm j \sin \theta$, Therefore, equation (4) was transformed as:

$$H(e^{j0.045\pi}) = \frac{2.5 \times 10^{-3} - j5.26 \times 10^{-4}}{-1.75 \times 10^{-3} - j3.2 \times 10^{-3}}$$

Then, the magnitude and phase of both numerator and denominator can be obtained using the following relationship:

$$\text{For, } Z = |Z| = a \pm jb, \rightarrow M = \sqrt{a^2 + b^2}$$

Therefore, Magnitude and phase for numerator

$$\text{Magnitude, } M_1 = 2.5 \times 10^{-3}, \text{ Phase, } \theta_1 = \tan^{-1}\left(\frac{b}{a}\right) = 0.21$$

Magnitude and phase for denominator

$$\text{magnitude, } M_2 = 3.49 \times 10^{-3}, \text{ Phase, } \theta_2 = \tan^{-1}\left(\frac{b}{a}\right) = -1.08$$

$$H(Z) = \frac{Y(Z)}{X(Z)} = \frac{2.5 \times 10^{-3} e^{-j0.21}}{3.45 \times 10^{-3} e^{-j1.08}} = 0.72 e^{j(-0.21+1.08)} = 0.72 e^{-j(0.87)}$$

Therefore,

$$\text{Magnitude, } M = 0.72, \text{ and Phase, } \theta = 0.87 \text{ rad}$$

Since the filter is third order therefore, $\theta = 3 \times 0.87 = 2.61$

4.5 Poles and Zeros Analysis

This section analyses poles and zeros of the designed filters, most of the digital filters analyzed by their poles and zeros along with its gain factor. Poles and Zeros

providesuitable information about the filter’s response. Similarly, it served as the basis for digital filter design.

4.6 System’s Pole-Zero

The Matlab function “zplane(A,B)” was used to obtained the system’s poles and zeros as dificted in Figure 4.

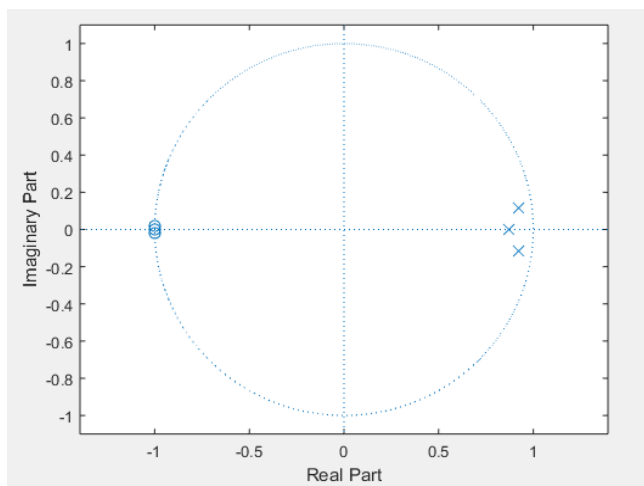


Figure 4: System Poles and Zeros Plot Diagram

Figure 4 illustrates the Poles-Zeros of low-pass filter. It has been observed that, the poles are placed close to the unit circle, at a point corresponding to low frequencies. Equally, the Zeros placed close or on the unit circle which corresponds to high frequencies.

Zoomed system’s
From the Figures
observed that, the
equals to the
and zeros. The

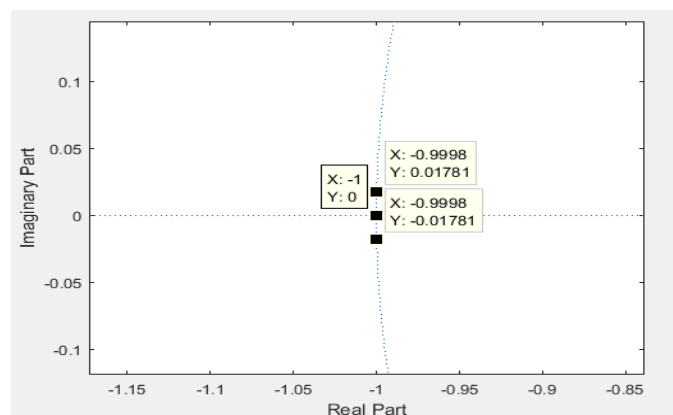


Figure 5:
zeros plot

the entire poles are less than one (1) and within the unit circle. Therefore, the system is said

to be stable. This is as a result of the known fact that, a recursive filter is always stable if all its poles have magnitude of less than one (1). Figure (4 & 5) also illustrated that, all the poles are conjugate pairs and are within the unit circle.

4.7 Acoustic signal analysis

Achieving all the above procedures of low-pass filter design stages, therefore, next is to test the result obtained by means of passing the signal through the designed filter input. This is the main aim of the research. The acoustic signal obtained from an Ambulance siren was inputted, processed and the output was obtained as shown in Figure 5(a & b).

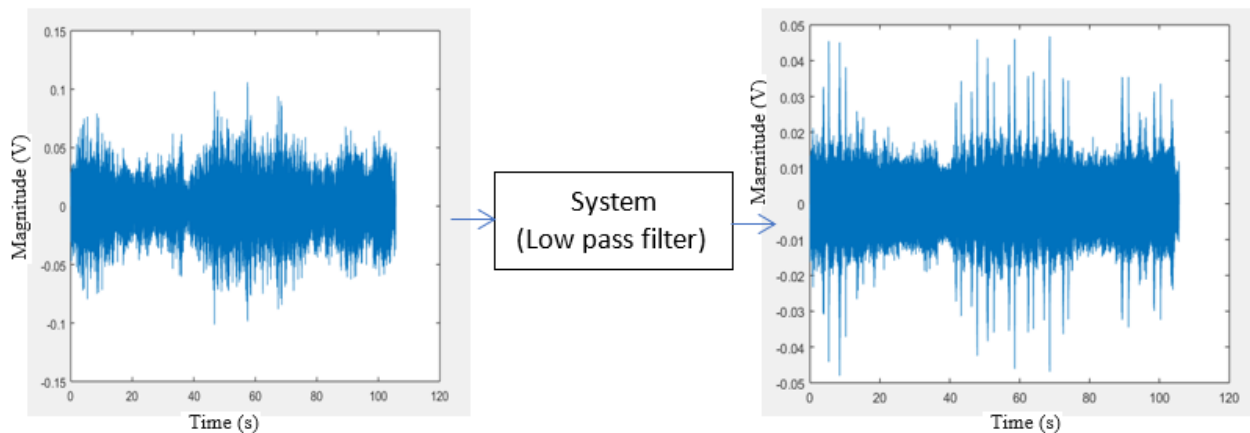


Figure 5a: Filter input signal Figure 5b: Filter output signal

Figure 5a depicted the acoustic input signal into the system, which processed and produced the output signal as in Figure 5b. The input signal has a range of amplitude between -0.1V to $+0.1\text{V}$. Which after being processed by the filter produced an output signal with a new amplitude of -0.049V to $+0.049\text{V}$. This indicated that, the designed filter removes all the higher frequencies and some unwanted signal thus noise. Therefore, the system output can be considered as a smooth Acoustic signal as in the Figure 5. One of the functions of a low-pass filter is to reduce the amplitude of the signal components that are beyond the some cut-off frequency.

4.8 Magnitude and Frequency Spectrum

The transformation of Acoustic signal from time domain to frequency domain is essential in order to obtain the frequency spectrum. To achieve this a MATLAB function was adopted, considering FFT of a small content of the Acoustic signal via the length and frequency. Similarly, MATLAB function ('fft') was used to evaluate the frequency components of the signal. Considering the complexity nature of signal (FFT) data normalization is required to

have a better plot. Hence, MATLAB function (specx) was utilized. Therefore, the magnitude frequency spectrum of the ambulance signal was obtained as portrayed in Figure 6

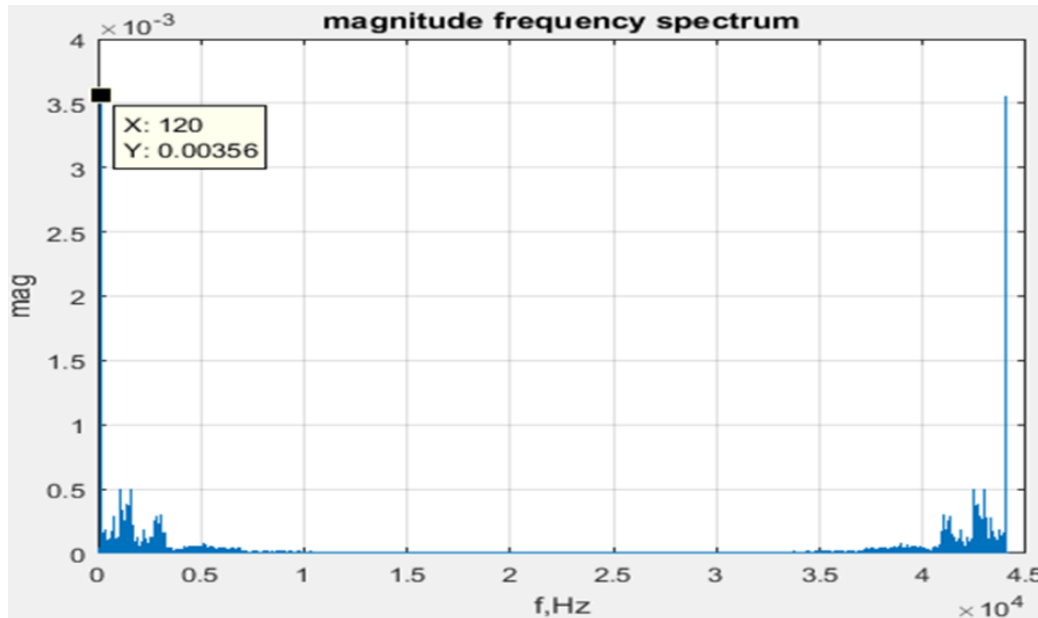


Figure 6: The magnitude frequency spectrum of the ambulance signal

The magnitude - frequency spectrum as in Figure 6 displays a two-fold sided spectrum with a mirror-image at exactly $\frac{f_s}{2}$. This also specifies that at 120 Hz frequency there is a spectral peak. This signifies that the signal encompasses some useful information. Figure 6 also shows that many spectral components can be determined. However, Figure 6 lacks time-information components that will specify the time at which a particular frequency occurs. Spectral peak frequency is obtained as 0.00356×10^4 Hz as revealed in Figure 6.

4.9 Short-Time Fourier Transform (STFT)

To remedy the above-mentioned problems of FFT concerning time-information components, there is the need to introduce Short Time Fourier Transform (STFT), which is known as spectrogram. This can be achieved by means of a signal processing method used for analyzing non-stationary signals, especially those that magnitude and frequency varies with time. STFT explores many frames of the signal and analyzes them with a window that changes with time. To obtain a spectrogram of the signal using MATLAB, a Kaiser window of length $L=2048$ and shape parameters 5, specifying 1024 samples of section-to-section overlap and f is the DFT points as shown in Figure 7.

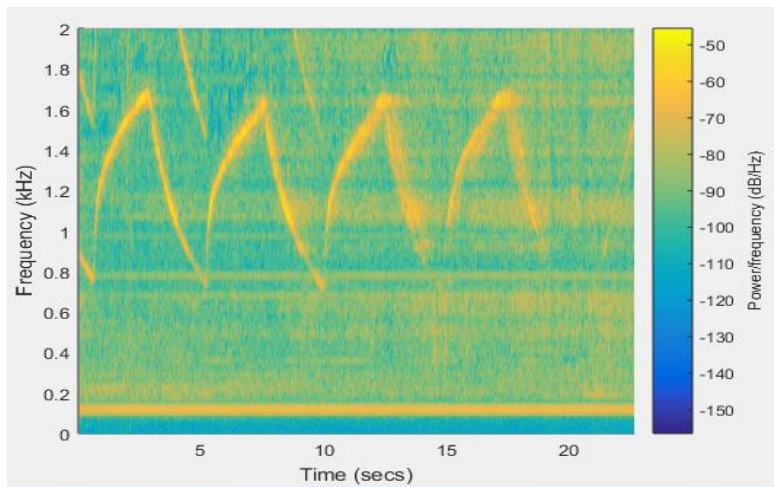


Figure 7: The spectrogram of the ambulance signal

Figure 7 depicted the spectrogram of the ambulance siren. The colors of the spectrogram encrypt the power levels. The yellow colors indicate frequency component with advanced power and the blue colors show the low-power frequency component. A horizontal strong yellow line designates the presence of a sound tone at a specific frequency.

4.10 Performance Evaluation

This section is dedicated to investigating the effects of the parameters on the output of the system. This is to characterize and evaluate the performance and accuracy of the designed system using Artificial Neural Network (ANN). The parameters of interest are learning rate, number of iteration and gain. This effect of these parameters is carried out on the training and testing phase, by utilizing and the result is shown in Table 2.

Table 2: Investigating the Effect of learning rate Related to Other Parameters

Gain	Learning Rate	Number of Iteration	Percentage Accuracy	Error
0.6	0.1	1000	100	0
0.6	0.5	1000	90	0
0.6	0.8	1000	95	0
0.6	1.0	1000	very accurate	0

Table 1 show the result of investigating the effect of learning rate related to other parameters to evaluates the percentage accuracy based on the number of iterations. Hence, the data obtained were utilized to plot the graph as illustrated in Figure 8.

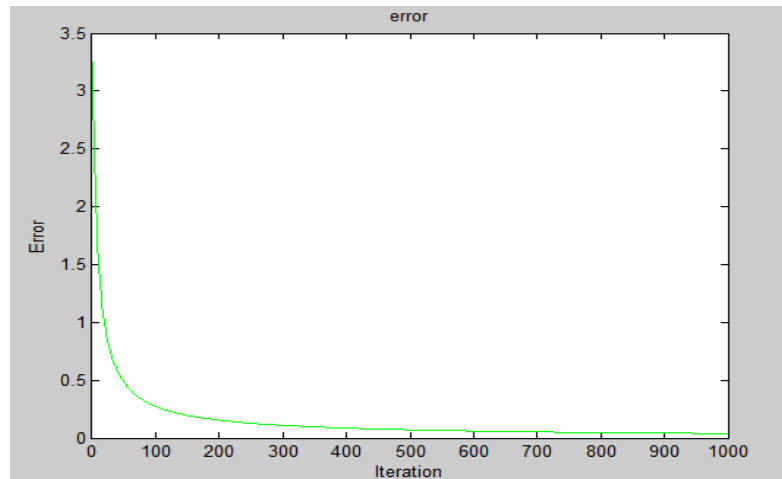


Figure 8: Learning rate 0.1, Gain 0.6, Iteration 1000

Figure 8 shows the relationship between error versus number of iterations and it shows that the errors reduce as the number of iterations increases, when the learning rate is 0.1.

5.0 Conclusion

This research paper proposed emergency vehicles siren signal enhancement using adaptive lowpass filter. The filter was designed by means of obtaining the first three values of the system's unit sample response, and the results were compared. Pole and zeros were determined for the system characteristics and stability. The designed low-pass filter reduced the amplitude of the input signal ranges (- 0.1v to + 0.1v) to (- 0.049v to + 0.049v). Hence, this indicates that the system (filter) removed all the higher frequencies and some unwanted signal thus noise. Therefore, the system output can be considered as smooth and enhanced acoustic signal. The Artificial Neural Network (ANN) analysis predicted that the system is of high accuracy.

5.1 Recommendation

Further work is needed especially in the area of advance spectrogram. This will provide a detailed view of sound with time, frequency and amplitude components all in a single graph. It can also disclose the broadband, electrical or intermittent noise in audio. Furthermore, advance spectrogram allows easy identification of noise from audio signal by sight.

A spectrogram is a detailed view of audio, able to represent time, frequency, and amplitude all on one graph. A spectrogram can visually reveal broadband, electrical, or intermittent noise in audio, and can allow you to easily isolate those audio problems by sight.

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ACADEMIC ENTREPRENEURSHIP RESEARCH IN THE PAST DECADE: A SYSTEMATIC REVIEW

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ABSTRACT

Academic entrepreneurship refers to the combination of economic activities such as the commercialization of intellectual property generated by universities through activities like patenting, licensing, establishing spin-off companies, and fostering collaborations between academia and industry with the traditional roles of the university. Using SQAT methodology, this article examined the trend in this emerging research domain in the past decade. Five premium academic databases were searched using the keyword “Academic Entrepreneurship” and a total of 52 articles that met the selection criteria to be included in this review. Analysis revealed that articles were published every year on the subject matter, the peak being 2017 and 2019. In terms of thematic focus, the most dominant reoccurring theme in the review period include spin-offs venture and the usefulness of Technology Transfer Officer as special purpose vehicle for repositioning traditional universities to take advantage of the emerging digital economy.

Key Words: Academic Entrepreneurship, Entrepreneurial University, Technology Transfer Office.

Introduction

In recent times, the integration of entrepreneurial activities within the academia has emerged as the third mission of universities around the world (Maximilian, 2019). Traditionally revered as bastions of knowledge creation, dissemination, and innovation diffusion; universities now find themselves at a crossroads. Shifting technological landscapes, evolving demographics, and tightening of public funding necessitate a reevaluation of their core missions. Failure for universities to adapt risks stagnation in an era where dynamism permeates every facet of the economy. Consequently, universities are driven to adapt and broaden their missions to include a fresh dimension of venture creations termed academic entrepreneurship which emphasizes the transfer of academic research from labs into markets (Wood, 2009). This concept is alternatively referred to by scholars as academic capitalism (Mendoza, 2012; Sigahi and Saltorato, 2020), academic spin-offs (Rasmussen and Wright, 2015; Ferretti et al., 2020), university entrepreneurship (Audretsch, 2014; Eesley and Lee, 2021), or academic entrepreneurism (Lam, 2024).

Over the past decades, scholars have devoted significant time and effort to elucidating the intricacies of academic entrepreneurship, resulting in a vast body of literature within this research domain. This extensive exploration has yielded a multitude of definitions for the term, reflecting the diverse perspectives and nuances inherent in the concept. According to Gubbins et al. (2020) academic entrepreneurship encompasses a wide range of venturing activities such as the commercialization of intellectual property generated by universities

through avenues like patenting, licensing, establishing spin-off companies, and fostering collaborations between academia and industry. Hayter et al. (2018) characterize academic entrepreneurship as the establishment of fresh business endeavors by faculty, postdoctoral researchers, students, or those affiliated with the university, utilizing university technology. A broader perspective, as outlined by Klofsten and Jones-Evans (2000), expands this definition to encompass any activities extending beyond traditional academic duties such as teaching and personal research. Furthermore, academic entrepreneurship can be conceptualized, according to Abreu and Grinevich (2013), as ventures characterized by innovation, risk-taking, and the potential for either direct or indirect financial gains for the scientist or the institution.

Building upon this definition, some other researchers have expanded the scope of academic entrepreneurship to incorporate not only the process of commercialization but also the cultivation of an entrepreneurial culture within university administration and the involvement of alumni in entrepreneurial activities stemming from the university (Philpott et al., 2011; Guerrero et al., 2020), and forging close alignment between university mission and essential industries (Kaklauskas et al., 2018; Thomas and Paul, 2019).

Various empirical studies conducted by multiple researchers have demonstrated the significant impact of academic entrepreneurship (AE). This impact is evidenced in areas such as stimulating regional economic activities where universities are located (Audretsch et al., 2013); generating new jobs (Siegel and Wright, 2015; Adelowo and Surujlal, 2020); creating new wealth opportunities (Wright et al., 2021); and forging strong ties between town and gown (Hayter, 2016). To put the phenomenal nature of academic entrepreneurship into a clearer perspective, a study conducted by Barbieri et al. (2018) examining the trade-offs associated with AE in Italy, findings revealed that academic researchers in the country secured a total of 527 patents over a span of seven years including the establishment of 115 active spin-off companies, indicating a notable preference for creating firms among academic researchers. This trend has emerged alongside traditional research collaborations between universities and businesses, signifying a diversification in the methods through which academia engages with the changing economic landscape.

In addition, Vincett (2010) urged that the impacts of spin-off ventures from AE constitute significant incremental contributions to the Gross Domestic Product (GDP), surpassing

government funding even when considering time-discounted values for public universities. This suggests that the economic benefits derived from spin-offs exceed investment made by the government, with additional tax revenues outweighing expenditures. Consequently, these impacts offer a quantitative rationale for public universities in Nigeria to rethink their approach to funding by recognizing the substantial economic value generated by spin-off ventures.

Governments, particularly in advanced economies, allocate significant public funds towards science, research, and innovation with the anticipation that such investments will stimulate economic growth, enhance competitiveness, and yield societal benefits. To assess the effects of these investments and understand the nuances of this research domain, numerous systematic reviews within the academic entrepreneurship (AE) sphere have concentrated on bibliographic and content analyses.

Therefore, the aim of this article is to bridge this gap by conducting an inductive review of the existing literature from 2013 to 2023. This review seeks to comprehend the thematic approaches employed and the extent to which they shed light on the elements of the academic entrepreneurship ecosystem and their interconnectedness. The remainder of the paper is structured as follows. Section 2 explains the methodological approach, section 3 lays out the findings and discussion of the review and finally, a synthesis of implications for Nigerian public universities and recommendation for future research agenda is made.

2 Methodology

The studies included in this review were gathered from six databases: Emerald, Elsevier, Sage, Springer, Taylor & Francis. These databases were selected due to their reputation for publishing only peer-reviewed papers. The choice was based on the understanding that peer-reviewed papers undergo a rigorous review process, contributing to their premium quality in academic research (Sidalak et al., 2017). This study adopted the Systematic Quantitative Assessment Technique (SQAT) developed by Pickering and Byrne in 2014. SQAT employs a systematic approach to evaluate articles for inclusion or exclusion in the review process. The emphasis is placed on screening peer-reviewed original journal publications to ensure only a high standard article quality is included (Pickering and Byrne, 2014). SQAT enables the researcher to identify “important geographic, scalar, theoretical and methodological gaps in the literature” (Pickering and Byrne, 2014, p. 11).

SQAT recommends five steps in conducting an effective systematic review. Each step and how it was applied in the current study is described in Table 1 below.

Table 1: Description and Application of SQAT

S/N	Step	Application in current study
1	Define topic	Academic Entrepreneurship (AE) articles published between 2013 and 2023
2	Formulate research questions	<p>Six research questions:</p> <ol style="list-style-type: none"> 1. What is the time distribution of AE research articles? 2. In which countries were these articles written? 3. What methods were used to collect data? 4. What methodologies were adopted? 5. What kind of AE articles were published? (Conceptual vs. Empirical) 6. What are the specific themes these articles explored, and what were the major findings?
3	Identify Keywords	“Academic Entrepreneurship”
4	Identify and search databases	<ol style="list-style-type: none"> 1. 5 databases utilized: Emerald, Elsevier, Sage, Springer, Taylor and Francis 2. “All in title search” using the phrase “Academic Entrepreneurship”

- 5Read and assess publications
1. Abstracts of articles found were read to ensure that they were dealing with entrepreneurial ecosystem.

2. Literature reviews, book chapters and conference proceedings were not included; only peer-reviewed conceptual and empirical articles.

Source: Author, 2024

A total of 52 peer-reviewed AE articles met the selection criteria from five prominent academic journal publishers. Table 2 presents the AE articles breakdown by publisher.

Table 2: AE Articles reviewed by publisher (2013-2023)

S/N	Publisher	Number of AE Article
1	Emerald	14
2	Elsevier	17
3	Sage	4
4	Springer	14
5	Taylor and Francis	3
	Total	52

Source: Author, 2024

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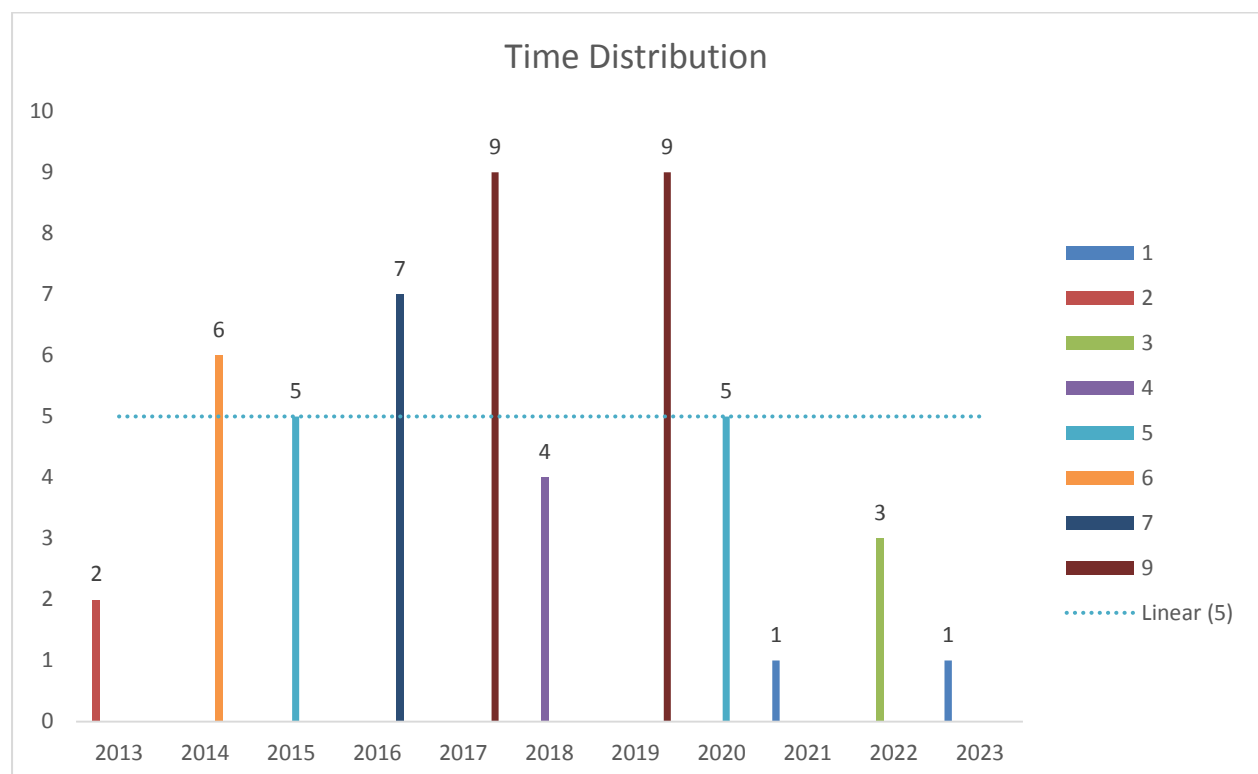
Findings and Discussion

3.1

Time Distribution of AE Articles

The paper examined a total of 52 articles that met the selection criteria, spanning from 2013 to 2023. A time distribution analysis of AE research was conducted, revealing notable patterns. The years 2017 and 2019 emerged as the peak years for publications, each contributing 9 articles, collectively representing 17.31% of the total publications throughout the decade. Following closely, 2016 saw the second-highest number of articles with 6 publications, while both 2015 and 2020 had 5 articles each. Conversely, the years 2021 and 2023 had the lowest publication rates, with only one article each. It's worth noting that articles were consistently published each year within the reviewed decade (2013-2023). Figure 1 provides a visual representation of the data.

Fig. 1: Time Distribution of AE articles



Source: Author, 2024

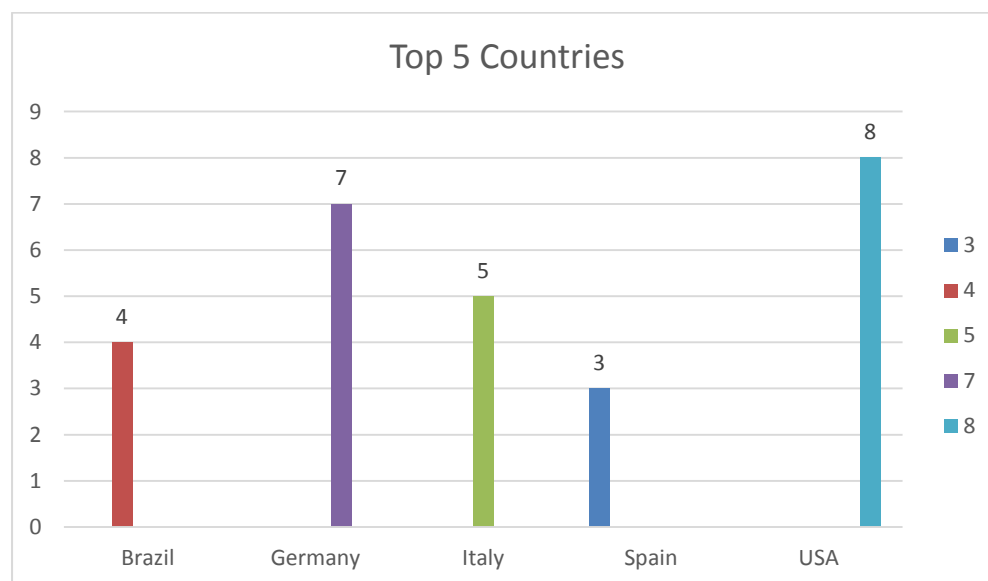
3.2. Geographical Distribution of Articles of AE

Additional analysis revealed that AE articles predominantly originated from Europe, with only one article emerging from Africa within the last decade. Figure 2 illustrates a breakdown of the top five countries contributing studies reviewed in this paper. According to the data presented, 8 articles were published in America, accounting for 15.38% of the total; Germany

contributed 7 articles, representing 13.46%; and Brazil contributed 4 articles, making up 6.79% of the top five countries in AE publications in the last decade.

The United States leading in AE is not a surprise because academic venturing began there with the enactment of the Bayh-Dole Act. The significance of the Bayh-Dole Act of 1980 in the history of AE cannot be overstated. This pivotal legislation prompted universities across the United States to establish technology transfer offices, facilitating the patenting and licensing of their research findings (Schmitz et al., 2017). According to Mowery (2005) a key factor behind the economic resurgence of the United States in the 1990s was the collaboration between universities and industries in research, as well as the subsequent technology transfer. This was particularly evident in the licensing of patented inventions by U.S. universities. The surge in U.S. university patenting and licensing after 1980, coupled with the broader expansion of high-technology entrepreneurship within the U.S. economy during the 1990s, is often attributed to shifts in public policy, notably the Bayh-Dole Act of 1980.

Fig. 2: Geographic Distribution of AE articles



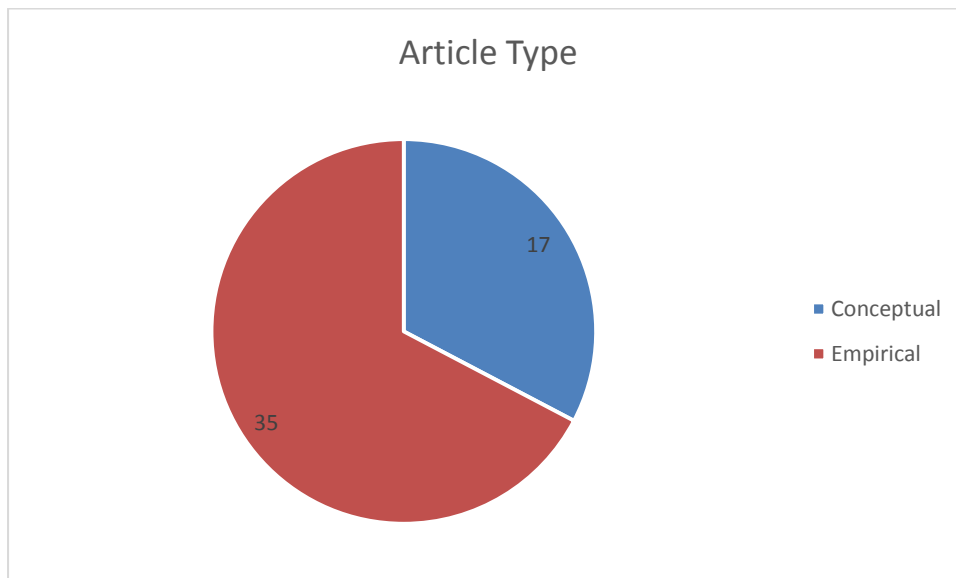
Source: Author, 2024

3.3 Types of AE Articles

The articles were categorized into conceptual and empirical papers. Figure 3 illustrates the distribution of the 52 articles based on this classification. Majority of the reviewed papers, totaling 67.31% (35 out of 52), are identified as empirical in nature, while the remaining

articles fall under the conceptual studies category as shown in the graph below. The predominance of empirical research during the review period indicates a strong emphasis on gathering and analyzing real-world data to investigate and validate hypotheses, theories, and models in the field. This empirical focus underscores a commitment to rigor and evidence-based inquiry, contributing to a deeper understanding of the phenomena under study and facilitating the development of practical applications and solutions. Hayter et al. (2018) urged that scholars have basically devoted attention to individual elements and characteristics units of analysis, while abjuring strategic and systemic conceptualizations as a result empirical research presents a first step towards addressing this gap by providing concrete insights into the dynamics and interactions within entrepreneurship ecosystems. This foundational understanding can serve as a springboard for future research endeavors aimed at developing more holistic and strategic conceptualizations of AE variables, thereby enriching our comprehension of the multifaceted nature of entrepreneurial ecosystems and informing policy and practice in this domain.

Fig.3 Article Types



Source: Author, 2024

3.4 Data Collection Methods

Figure 4 presents the different data collection methods employed for the articles reviewed for this study. Thirty-five empirical articles were reviewed in terms of the data collection method adopted by the researchers. Out of the reviewed articles, twenty (20) articles representing 38.46% adopted survey as a method of primary data collection techniques for their studies, while seventeen articles (17) representing 32.69% used questionnaires for data collection for their studies. Others were interviews and mixed methods representing 13.47% and 15.35% respectively.

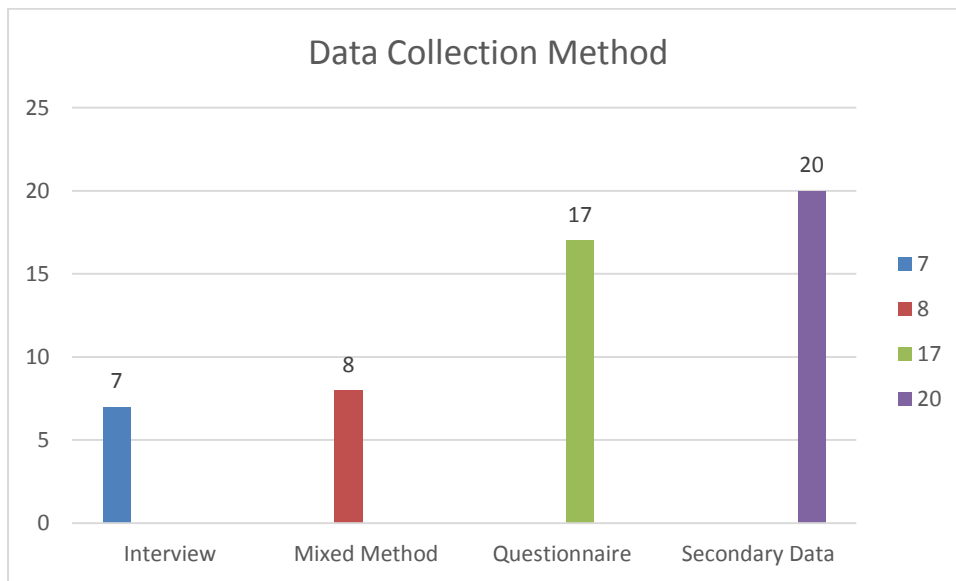


Fig. 4: Data Collection Method

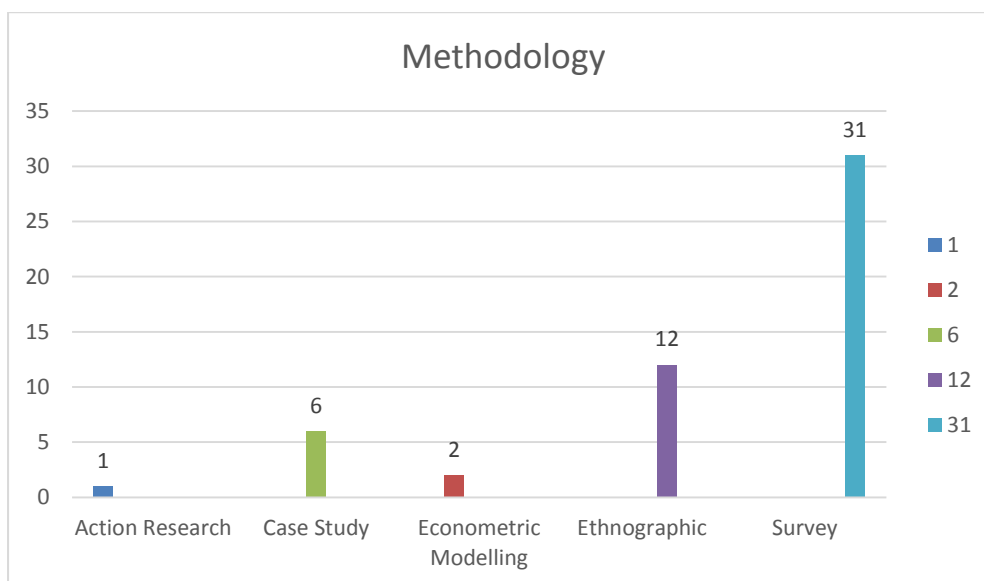
Source: Author, 2024

3.5 Methodologies

Researchers in the reviewed articles utilized five distinct methodologies, as depicted in Fig. 5. The predominant research method was surveys, with 31 articles, constituting 59.61% of the total reviewed articles, favoring this approach. Ethnographic techniques ranked second, with 12 articles, representing 23.07%. Additionally, some researchers employed case studies (6 articles) and the action research approach (1 article) respectively. It is evident that ethnographic methodology was popular among researchers. This approach entails immersive observation, active participation, and interaction with the subjects under study over a prolonged duration. Ethnographic research often opts for a small number of cases to generate rich, detailed data. It centers on human interactions in everyday settings, aiming to capture

insights beyond formal research contexts. Moreover, it places a strong emphasis on fostering relationships with participants to gain access to their insider perspectives (Reeves et al., 2008; Gertner et al., 2021). For instance, Shepherd and Woods (2014); Han and Niosi (2016); Cantu-Ortiz et al.(2017); Sapir, (2020); etc. adopted this methodology. In the case of Sapir, (2020) who directed his research towards validating the internal legitimacy of AE. His inquiry stemmed from contentions surrounding the ethical considerations of universities shifting towards profit-driven models. Sapir proposed that the consensus among organizational participants regarding the acceptance or normative validation of a strategy acts as a mechanism to fortify organizational practices and rally members around a unified ethical, strategic, or ideological vision.

Fig. 5: Methodology



Source: Author, 2024

3.6 AE Research Themes

Analysis of 52 articles conducted during the review period unveiled several intriguing thematic patterns. These themes shed light on various aspects of the research landscape and provide valuable insights into emergent trends and prevalent topics within the AE research domain. Only dominant themes which occur in more than 3 articles are given in-depth consideration in this section. The most dominant reoccurring theme in the review period is

spin-offs ventures. Civera et al. (2020) examined the concept of opportunity-oriented and necessity-oriented academic spinoffs. According to Horta et al. (2016) there is substantial evidence indicating that the genesis of spinoffs isn't exclusively driven by opportunity discovery. Instead, university researchers may find themselves compelled into academic entrepreneurship due to circumstances such as the need to supplement their modest incomes, rather than being solely motivated by a passion for launching a business venture. The findings of Civera et al. (2020) corroborate this notion, suggesting that some university-based enterprises are often reactive solutions to challenging circumstances, rather than proactive responses oriented towards market opportunities. This implies a significant departure from the traditional narrative surrounding academic spinoffs, highlighting the diverse motivations and contexts that underpin their establishment.

In addition, other studies such as those by Kolympiris et al. (2015) and Sciarelli et al. (2021), also explore AE through the lens of spin-off companies. Kolympiris et al. (2015) investigated the impact of various factors on the success of university spin-offs ventures in Italy. Their analysis focused on the composition of the founding team, the diversity of academic ownership, CEO duality, and the presence of women on the board of directors across a sample of 123 spin-off firms. Their findings reveal that university spin-offs with significant involvement from external entities tend to exhibit superior performance in terms of market sales and job creation compared to those with fewer outside equity partners. This suggests that achieving the right balance between academic and non-academic members within the founding team and board of directors can be a crucial determinant of economic success for spin-off ventures. This underscores the importance of collaboration and diversity in fostering the growth and sustainability of academic spin-offs, emphasizing the potential benefits of integrating external expertise and perspectives into university-led entrepreneurial business.

Moving on, another significant theme that surfaced from the analysis pertains to the operations of Technology Transfer Offices (TTO) and the formulation of intellectual property and patent policies within such establishments. Researchers such as Czarnitzki et al. (2016), Schaeffer and Matt (2016), Barbieri et al. (2018), Sandström et al. (2018), Astebro et al. (2019), and Halilem et al. (2017) have delved into these thematic areas to lay bare factors that affects commercialization of academic research. Schaeffer and Matt (2016) explored the evolution of TTO as a hub that stimulate university spin-offs in a non-mature entrepreneurial environment by acting as ecosystem builders. The pertinent research question of the study

was how do TTO support academic start-up creation in a non-mature entrepreneurial ecosystem such as Nigeria? To address this question, the researchers conducted a case study focusing on the University of Strasbourg, renowned for its world-class research capabilities, substantial industry funding, and a track record of successful university start-up ventures. Spanning a period of 12 years, their study unveiled the intricate network orchestrated by the university which included innovation intermediaries, local political and institutional stakeholders, and innovative companies.

The findings underscored the critical role of this network in positioning the University of Strasbourg as a prominent influencer within the regional innovation system of France. By leveraging its robust connections and collaborative partnerships, the university effectively nurtured an environment conducive to the emergence and growth of academic spin-offs. This highlights the significance of strategic networking and ecosystem development initiatives orchestrated by TTOs in fostering entrepreneurship and innovation within non-mature entrepreneurial landscapes.

Table 3. Summary of findings of reviewed AE articles

S/N	Heading	Key Finding	Implication
1	Time Distribution (2013-2023)	<ul style="list-style-type: none"> • AE articles were published every year from 2013-2023. • The most articles were published in 2017 and 2019 with combined 18 articles. 	This suggests that researchers may have perceived AE as a particularly salient and relevant topic during those periods.
2	Geographic Distribution	<ul style="list-style-type: none"> • Meta-analysis of 52 articles showed that 26 countries were represented. • The most articles emerged from USA. 	There is need for AE research in the context of African public universities.
3	Article Type	<ul style="list-style-type: none"> • Majority of the article during the period were empirical in nature (35 out of 52), only 17 were conceptual papers. 	the prevalence of empirical research signals a commitment to rigor and objectivity in understanding the dynamics, outcomes, and factors influencing AE activities.

- 4 Data there exists a wealth of
collection • Four different data collection existing information and
Methods method were identified. resources that researchers
• Secondary data was the most can leverage to study AE.
common data collection
technique (20).
- 5 Methodology • Five different methodology The prevalence of survey
were identified. indicates a willingness to
Survey was the most common research capture the nuances of AE
approach (31). phenomena to produce
meaningful and actionable
findings.
- 6 AE Themes Meta-analysis of 52 articles showed This suggests a growing
different authors examined diverse recognition of the
facets and variables of AE using importance of bridging the
different unit of analysis and spatial gap between academia and
perspective. Among the themes are industry, as well as the
determinants of AE, barriers and need to establish robust
constraints, social networks, university mechanisms for translating
incubators, etc. academic innovations into
tangible products, services,
The dominant themes include spin-offs or technologies.
venture and TTO related to patent and

IP policy.

Source: Author, 2024

4 Conclusion and Implications for Nigerian Universities

This current study conducted a systematic review of the AE research landscape aiming to shed light on thematic trend in the last decade. SQAT methodology was adopted to evaluate articles for inclusion during the review period. 52 peer-review journal articles on the subject matter were reviewed based on five key headings including time distribution, geographical distribution, article type, data collection methods and prevalent themes.

Majority of the examined articles present empirical evidence indicating a transition towards entrepreneurial universities. A key implication of these findings underscores the crucial role of Technology Transfer Offices in establishing the dominance of an entrepreneurial economy. In such an economy, knowledge capital emerges as the primary driver of competitive advantage, complemented by entrepreneurship capital, which signifies the ability to initiate and drive entrepreneurial activities. Consequently, an entrepreneurial economy creates conducive environments wherein its constituents such as the academia can actively explore and capitalize on new knowledge. This facilitates the emergence of innovative entrepreneurial phenomena previously unseen or envisioned.

We speculate that the shift towards this new model is a response to significant environmental changes that have rendered the traditional university approach inadequate. Factors such as dwindling government funding, unemployment crises, the desire of academics to express their entrepreneurial instincts, and most importantly, the rise of an entrepreneurial economy led by tech giants like Google and Facebook, which have greatly benefited from their proximity and partnership with universities.

While the requisite research to validate or refute this conjecture in the context of Nigeria and African at large remains to be undertaken, the focus of this article is to suggest that academic entrepreneurship not only offers a pathway for Nigerian universities to attain financial independence but also serves as a fertile ground for graduates to imbibe the true spirit of entrepreneurship.

This trend is already emerging in Nigeria with initiatives like the "Uni-innovator Program," which enables students with innovative ideas to collaborate with industry experts in an incubator setting to gain practical experience in developing ideas into products and bringing them to market. This program has been launched at the University of Ibadan and the University of Lagos, and being funded by GIZ. In addition, the licensing of Miva University to operate as the first online tertiary institution in Nigeria, led by one of the country's most prominent high-growth technology entrepreneurs, the clock for the emergence of the entrepreneurial university in Nigeria is already ticking. We anticipate that in the next decade, Nigerian universities will gain partial autonomy, and those who recognize the emerging trends early will be better positioned to attract external funding and talented, tech-savvy students who have experienced the transformative potential of technology.

This review is not without limitations that provide opportunities for refinement in future research. Firstly, the scope of the study was bounded to articles published exclusively on databases such as Emerald, Elsevier, Sage, Springer, Taylor and Francis. This selective approach might have resulted in the exclusion of valuable studies on AE published in other database. Future researchers could broaden the selection criteria to cover a more diverse range of publishing sources. Secondly, the inclusion criterion focused solely on articles explicitly featuring "Academic Entrepreneurship" in their titles. This might have overlooked relevant contributions where authors did employ key words such "University Entrepreneurship", "Academic Entrepreneurism", etc. A more expansive search strategy could address this limitation in future study. Lastly, the timeframe for article selection was constrained to the years 2013 to 2023, introducing a temporal limitation to the study. Future research could benefit from a more extensive temporal scope to capture a broader spectrum of the subject matter.

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EVALUATING THE LEVEL OF COMPLIANCE OF BUILDINGS WITH PHYSICAL PLANNING STANDARDS AND REGULATIONS IN MINNA, NIGER STATE.

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ABSTRACT

Urbanization poses challenges to cities, particularly in adhering to physical planning standards and regulations. This study assesses compliance levels of physical developments with urban planning standards in Minna, Niger State, considering factors influencing compliance. It reviews historical urban planning in Minna, current regulatory frameworks, and impacts of compliance. The study adopted a combined research approach, that is, qualitative and quantitative approach. The primary data was gathered through questionnaire, field observation and photographs, while the secondary data was obtained from the planning bodies concerned with controlling/ monitoring development in Minna that is, Ministry of Lands and Survey and Niger State Urban Development Board (NSUDB) through interview. Secondary data was also obtained from Abuja Electricity Distribution Company (AEDC), journals, past researches and others. The sample size of the study is 276 developments. The sampling techniques used for the study is the stratified and purposive sampling techniques. Findings reveal significant non-compliance, influenced by factors such as poor enforcement, lack of awareness, poverty, and market dynamics. Recommendations include enhancing enforcement, increasing awareness, addressing poverty, and streamlining approval processes to promote sustainable urban development.

INTRODUCTION

Urban planning regulations are critical for sustainable city development, ensuring orderly growth and efficient use of resources. In Minna, Niger State, rapid urbanization has raised concerns about adherence to these regulations. This paper aims to assess the compliance level of physical developments with the urban planning standards set by local authorities. It will explore the historical context of urban planning in Minna, the current regulatory framework, and the impacts of compliance or lack thereof on the city's infrastructure, environment, and residents. In 2016, it was estimated that over half of the global population resides in cities; analysis has it that these urban areas will put up 60% of the global population by 2030, potentially attracting development control challenges (Wilfred, 2019). Agenda 21 which is a product from the United Nations Conference on Environment and Development (UNCED) in 1992 highlighted the relevance of land use planning, and recommended effective planning by

urging countries to initiate development control measures to enhance sustainable land use (Wilfred, 2019).

In Nigeria, the beginning of development control is associated with the land tenure system operated by the North and Southern parts of the country. Land was vested in the hands of the traditional rulers such as the Emir, Oba and Obi for onward usage as it may be necessary and conditions were set for acquisition (Vivian, et. al. 2013). Town and Country planning necessitated the formulation of ordinances that affects health, land use, roads and environmental preservation, classification of towns became operational. In order to make Town and Country Planning more relevant and effective, the power to function was vested in the local government area and with the creation of more local government areas in 1976, planning authorities were established to handle planning matters (Vivian *et.al*, 2013).

Development control measures have not been successful in some parts of Nigeria because necessary support is not coming from the government (Vivian, et. al. 2013). Uncertainty, fears are associated with the exercise not actually knowing that the benefit derivable from it outweighs the disadvantages. In tackling physical development control measures and to improve the general well-being of the public, the Urban and Regional Planning Decree (88) of 1992 was promulgated. For physical development and social well-being to be realized, this act has to be in use (Vivian *et.al*, 2013).

Presently, development control is subjected to considerable criticism about the nature of decisions taken and also the ways in which they are taken. Like most cities in Nigeria, Minna has been urbanizing rapidly. With the resultant consequences of uncontrolled development. That is, the rate of expansion of each of old and newly emerging neighbourhoods led to the emergence of uncoordinated land uses, traffic congestion, uncoordinated provision and distribution of socio-physical infrastructure, uncollected waste and so on, amongst others, with the great impact on the socio-economic well-being of residents.

Minna city has a master plan and all development have to be undertaken in accordance with the approved physical development plan of the area. However, open spaces have been taken over by buildings/structures. Minna is the capital city of Niger State which is supposed to serve as a model to other towns in the state, this then calls for a need to mitigate against the negative effects of urbanization. Kahi (2015) has revealed that planning should always be seen at the forefront of development, planning laws should be enforceable to ensure sustainable development.

Minna city development plan is supposed to guide development but this has not been the case. Informal and illegal developments should not be seen in the city. Spill over developments that have gone beyond the planned boundary can be observed. These developments have created challenges to physical planning and development as the city expands. This may mean that spatial planning will be reacting to urban development rather than directing it.

Statement of Research Problem

Minna, the capital of Niger State, has been experiencing rapid urbanization, leading to significant physical development across the city. However, the adherence of these developments to established physical planning standards and regulations remains a critical concern. Non-compliance with zoning laws, building codes, and environmental regulations can result in numerous urban challenges, including haphazard growth, inadequate infrastructure, environmental degradation, and diminished quality of life for residents. Despite the existence of regulatory frameworks designed to guide orderly and sustainable urban development, there is evidence to suggest that many buildings in Minna fail to comply with these standards. This non-compliance raises questions about the effectiveness of the enforcement mechanisms, the factors driving non-compliance, and the broader implications for the city's development. The core issue this research seeks to address is the extent to which buildings in Minna adhere to physical planning standards and regulations, the underlying reasons for non-compliance, and the impact of this non-compliance on urban sustainability and resident well-being. By identifying the gaps in compliance and the challenges faced by regulatory authorities, this study aims to provide actionable recommendations to improve adherence to planning standards and promote sustainable urban development in Minna.

Aim and Objectives

The aim of this study is to evaluate the level of compliance of buildings in Minna, Niger State, with established physical planning standards and regulations, and to identify factors influencing compliance rates. The objectives of the study are as follows:

1. To assess the extent to which buildings in Minna adhere to zoning laws, building codes, and environmental regulations.

2. To identify the key factors influencing compliance with physical planning standards among property developers and builders.
3. To examine the effectiveness of enforcement mechanisms employed by urban planning authorities in Minna.
4. To analyze the implications of compliance and non-compliance on urban development and residents' quality of life in Minna.
5. To propose recommendations for improving compliance with physical planning standards in Minna.

Research Questions:

1. What proportion of buildings in Minna comply with the established zoning laws, building codes, and environmental regulations?
2. What are the main factors that influence the compliance behavior of property developers and builders in Minna?
3. How effective are the current enforcement mechanisms used by urban planning authorities in ensuring adherence to physical planning standards?
4. What are the consequences of compliance and non-compliance with physical planning standards on urban development and the quality of life of residents in Minna?
5. What strategies can be implemented to enhance compliance with physical planning standards in Minna?

The Study Areas

The Eastern By-Pass corridor which comprises of Kafin-Tela and Kampani communities is between the geographical coordinates of Latitude 9 35' 39.75'' N to 9 35' 41.07''N and Longitude 6 34' 52.05 E to 6 34' 26.39''E. It is located in Chanchaga Local Government Area of Niger State; Minna precisely. This neighbourhood is located along the Eastern By-Pass of the city and it is bounded by other neighbourhoods like Tunga and Maitumbi. Sauka-Kahuta lies between the geographical coordinates of Latitude 9 34' 48.05''N to 9 34' 5.32''N and Longitude 6 32'45.08''E to 6 33' 10.76''E. It is also located in Chanchaga Local Government Area of Niger State in Minna city. This neighbourhood is located along the

Minna Western-bypass. Shanu/Gbaiko is between Latitude 9 38' 43.31''N to 9 38' 23.31'' N and Longitude 6 30' 30.64''E to 6 29' 37.33''E. This neighbourhood is located along the Western By-Pass and it is closely bounded by other neighbourhoods like Dutsen-Gwari and Bosso Estate. It is located in Bosso Local Government Area in Minna Niger State.

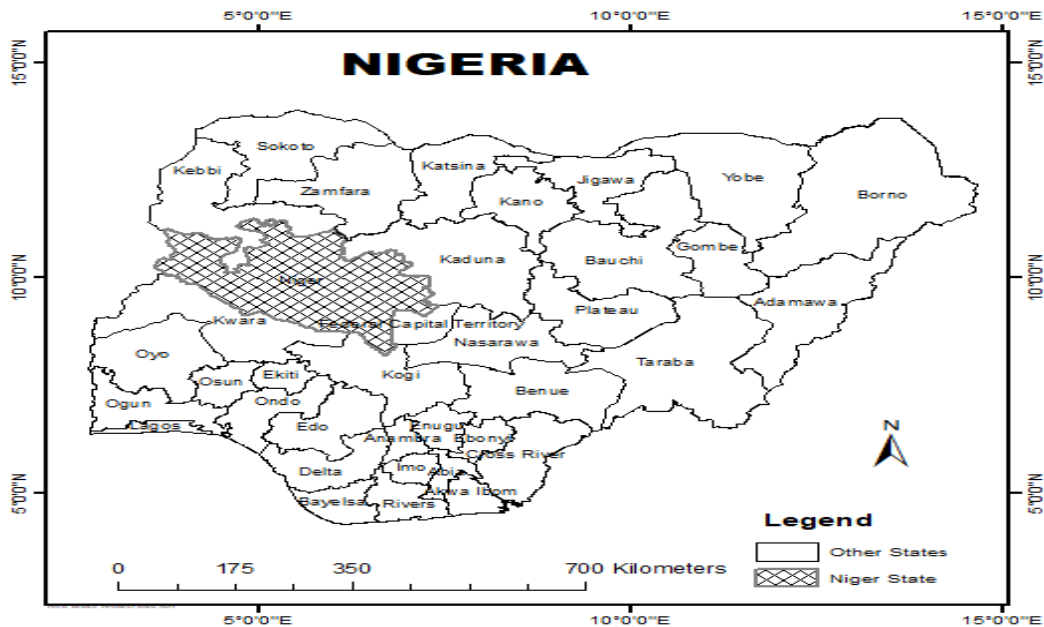


Figure 1.1: Niger state in the context of Nigeria.

Source: Ministry of Land and Housing Minna Niger State.

Figure 1.2: Chanchaga and Bosso L.G.A Niger state in Nigeria.

Source: Ministry of Land and Housing Minn, Niger State.

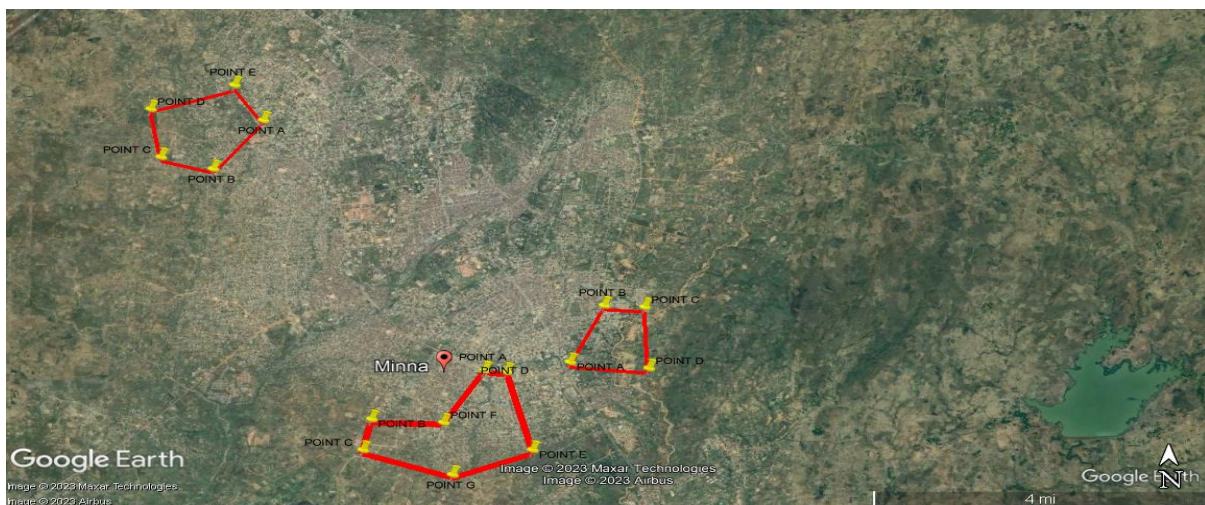


Figure 1.3: Google Earth Image of all Areas.

Source: Google Earth, 2023

LITERATURE REVIEW

Concept of Urbanisation

Palen (2008) stated that urbanization can be regarded as the steady increase in the number of people living in cities or urban centres. This occurrence results from the continuous mass movement of people from the villages or rural settlements to urban areas. It can also result from natural increase (excess of births over deaths) especially where the population increase take place in areas where advanced technology and developmental projects can be found. The definition of what qualifies a town as an urban centre differs from country to country depending on the population criteria used. For instance, in Sweden for as low as 200 inhabitants in a place can be classified as an urban centre, 250 persons for Denmark, in Canada 1000 persons, 10,000 in Greece while in Nigeria, a place is referred to as an urban when the population is as high as 20,000 inhabitants. Satterthwaite (2005) established that each nation uses its own criteria for defining urban centres depending on how the population is distributed.

Causes of Urbanisation

There had been various submissions as to what causes urbanisation, some of the reasons are industrialisation, commercialisation, social beneficial services, natural increase, employment opportunities and others, but for this work three main reasons will be discussed which encompasses every other reason;

- I. **Rural to Urban Migration:** In the context of this work, migration can be seen as the voluntary movement of people (as individuals, family units or large groups) from their home lands (place of birth or residency) to a new location with the intention of settling down temporarily or permanently due to economics and technological growth or advancement in their desired destination. The absence of essential basic amenities, unavailability of government presence and little or no commercial activities in the rural areas of most developing countries act as push factors that drives people away from the rural areas, whereas the cities of these countries remains the focus of government developmental projects and centre for several opportunities necessitating rural dwellers to

troop in their numbers to the cities due to these pull factors. In developing nations most especially, the main causative factors are rural-urban migration (Bodo, 2015).

II. Rural-Urban Transformation: Urbanisation process affects all sizes of settlements, therefore villages slowly grow to become small towns, smaller towns become larger towns and large towns become cities. This pattern has led to the growth of megacities. It is most likely that in some settlements, residents may not need to relocate to nearby cities for greener pastures but may see the opportunities they desire come to them, as some rural settlements transform into urban settlements (Bodo, 2019a). With time, the continuous inputs of scientific and technological knowledge in a small rural settlement can gradually metamorphise into a city. Incoming industries may start to build up commercial activities around their environment and beyond due to the discovery of minerals, resource exploitation and mechanized agricultural activities.

III. Negative Policies: According to Bodo (2019b) and Bodo and David (2018), the biggest influence on urbanisation presently is the government policies and programmes that are available in individual countries of the world. In Nigeria for instance, there is a system that focuses on transforming and adding more colours to the already built city where the seat of power resides. The Niger Delta people of Nigeria have complained over the years that the resources generated from the region have been used to develop Lagos and Abuja (former and present nation's capital cities) into megacities at their own detriment. The 36 state capitals in Nigeria have been the only areas of infrastructural development and creation of employment opportunities thereby creating permanent poverty and sufferings in the towns and villages surrounding these capital cities (Bodo, 2019a).

Factors Affecting Compliance with Development Control Regulations

In their policy paper on managing building developments, Architectural Association of Kenya (2011) outlined the factors which contribute to non-compliance to urban development control regulations:

- 1) Lack of Approved Physical Development Plans
- 2) High Professional Fees
- 3) Lack of Awareness of the Existence of Development Control Regulations
- 4) Poor Enforcement Mechanism
- 5) Political Interference and Lack of Political Will

- 6) Restrictive Planning Regulations
- 7) Effects of Market Forces

Effects of Non-Compliance to Development Control Regulations

Non-compliance to development control regulations has negative influence on the developers and society as a whole. To developers, the effect of non-compliance includes; demolition of non-compliant developments and/or fine or jail term. While the negative effects of non-compliance to the society are unhealthy environment, lack of aesthetics, inadequacy of provision for parking and children's playing grounds and loss of lives and property as a result of collapse of buildings (Architectural Association of Kenya, 2011)

- a. Land Use Conflicts and Demolitions
- b. Fines and/or Jail Term
- c. Unhealthy Environment
- d. Lack of Aesthetics
- e. Inadequate Provision of Parking
- f. Inadequate Provision of Children's Playing ground
- g. Loss of Lives and Property

MATERIALS AND METHOD

The study adopts a mixed-method approach. Quantitative data will be gathered through surveys of recent physical developments in Minna, assessing their compliance with zoning laws, building codes, and environmental regulations. Qualitative data will be collected via interviews with urban planners, government officials, developers, and residents. Document analysis of planning permits, violation records, and policy documents will provide additional insights. The sample sizes for the study were determined using the 50/50 split developed by Salant and Dillman (1994). The sample sizes for the study areas are as follows:

- Sauka-Kahuta which as a total of 5,556 houses has a sample size of 95
- Eastern by-pass corridor (Kafin-Tela/Kampani) has a total of 6,065 houses has a sample size of 95
- Shanu/Gbaiko which has a total of 626 houses has a sample size of 86

The total sample size for this study: Sauka-Kahuta = 95; Eastern By-pass (Kafin-Tela and Kampari) = 95; Shanu/Gbaiko = 86; $95 + 95 + 86 = 276$. So, the sample size for this study is 276 houses.

RESULTS AND DISCUSSION

The major findings that have emerged through data collection using household questionnaire, interviews with planning authorities, field observation and photographs. The data obtained was analysed to come up with findings on key study questions and objectives that this study intends to respond to and achieve.

Demographic Socioeconomic Distribution

Table 1 shows the demographic socioeconomic distribution of the respondents indicating that majority of the sample population is male (71%) while 29% are female. The age groups shows that the largest age group is 46-60 years old (42%), followed by 31-45 years old (34%). Also, the marital status indicates that most of the respondents are married (75%), followed by singles (16%). The majority of households have 5-8 members (57%). The educational level of the respondents shows that tertiary education (50%) has the largest portion, followed by secondary education (36%). Occupation Status Self-employed individuals comprise the largest group (30%). The monthly income of most of the participants is between N61,000 and N100,000 (30%). The type of development common is residential development (69%). The mode of land acquisition that has the most common mode is through purchase (44%). The ownership status and duration of stay reveals that most individuals own their homes with (47%) and majority of the respondents have stayed in their location for 6-10 years (33%).

Table 1: Demographic and Socio-economic Characteristics of the Respondents

Gender	Frequency	Percentage (%)
Male	155	71
Female	64	29
Total	219	100
Age Groups	Frequency	Percentage (%)

18-30yrs	35	16
31-45yrs	75	34
46-60yrs	91	42
61-75yrs	18	8
Total	219	100%
Marital Status	Frequency	Percentage (%)
Single	34	16
Married	164	75
Widow/Widower	14	6
Divorced	2	1
Separated	5	2
Total	219	100
Household Size	Frequency	Percentage (%)
1-4	71	32
5-8	125	57
13-16	17	8
17-20	5	2
Above 20	1	1
Total	219	100
Educational Level	Frequency	Percentage (%)
Primary	10	5
Tertiary	110	50
Secondary	79	36
No Formal	20	9

Total	219	100
Occupation Status	Frequency	Percentage (%)
Self-Employed	66	30
Unemployed	15	7
Trader	46	21
Civil Servants	58	26
Artisans	34	16
Total	219	100
Monthly Income	Frequency	Percentage (%)
₦30,000 or less	37	17
₦31,000 – ₦60,000	50	23
₦61,000 – ₦100,000	65	30
₦101,000 – ₦150,000	47	21
₦151,000 – ₦200,000	20	9
Total	219	100
Type of Development	Frequency	Percentage (%)
Mixed Uses	41	19
Residential	152	69
Commercial	22	10
Educational	3	2
Total	219	100
Mode of Land Acquisition	Frequency	Percentage (%)
Purchase	97	44
Inheritance	47	21

Lease	39	18
Agent	36	17
Total	219	100
Ownership Status	Frequency	Percentage (%)
Family House	57	26
Owner Occupier	104	47
Rented Apartment	58	27
Total	219	100
Duration of Stay	Frequency	Percentage (%)
Less than 2yrs	16	7
2-5yrs	57	26
6-10yrs	73	33
11-15yrs	35	16
16-20yrs	19	9
Above 20yrs	19	9
Total	219	100

Source: Author's Computation, 2024

The Level of Compliance of Buildings to Physical Planning Standards/ Regulations

In the course of the field work, the researcher investigated the level of compliance of buildings to physical planning standards/regulations with the tables below.

The table reveals significant variations in property document possession across three neighborhoods in Minna. In Sauka-Kahuta, a majority (59.5%) of residents hold Certificates of Occupancy, indicating higher formal property ownership, while Shanu/Gbaiko shows the lowest at 18.3%. Shanu/Gbaiko has the highest proportion of Sales Agreement Letters (23.3%) and a notable percentage of unspecified documents (28.3%), suggesting a reliance on informal agreements. The Eastern By-Pass area demonstrates a balanced distribution, with

40.5% holding Certificates of Occupancy and 29.8% possessing other types of property documents. These differences highlight the varying levels of formalization and types of property agreements preferred across these neighborhoods.

Table 2: Document in Possession Concerning Property

Document in Possession concerning Property	Selected Neighbourhoods					
	Sauka-Kahuta		Shanu/Gbaiko		Eastern By-Pass	
	Freq.	%	Freq.	%	Freq.	%
Certificate of Occupancy	44	59.5%	11	18.3%	34	40.5%
Lease Agreement	7	9.5%	12	20%	12	14.3%
Allocation letter	6	8.1%	6	10%	7	8.3%
Sales agreement letter	9	12.2%	14	23.3%	6	7.1%
Others (Specify)	8	10.8%	17	28.3%	25	29.8%
Total	74	100%	60	100%	84	100%

Source: Author's Computation, 2024

The table illustrates the adherence to building standards and regulations across three neighborhoods in Minna. In Sauka-Kahuta, the highest adherence is to setback regulations (32.4%), with notable compliance in plot coverage (20.3%), and a significant portion (13.5%) not adhering to any standards. Shanu/Gbaiko shows the highest compliance with plot coverage (33.3%), but a quarter of the buildings (25%) do not adhere to any standard, and only 8.3% comply with building line regulations. In the Eastern By-Pass, adherence is highest for plot coverage (48.8%) and plot ratio (23.8%), with minimal non-compliance (2.4%). These differences indicate varying levels of regulatory adherence, with Eastern By-Pass showing the highest overall compliance and Shanu/Gbaiko the highest non-compliance.

Table 3: Standard/Regulation Adherence on Building

Adherence to Building	Selected Neighbourhoods		
Standard/Regulation	Sauka-Kahuta	Shanu/Gbaiko	Eastern By-Pass

	Freq.	%	Freq.	%	Freq.	%
Plot Coverage	15	20.3%	20	33.3%	41	48.8%
Building Line	11	14.9%	5	8.3%	4	4.8%
Plot Ratio	8	10.8%	3	5%	20	23.8%
Building Height	6	8.1%	8	13.3%	2	2.4%
Set Back	24	32.4%	9	15%	15	17.9%
None	10	13.5%	15	25%	2	2.4%
Total	74	100%	60	100%	84	100%

Source: Author's Computation, 2024

The factors influencing physical development approval processes were ranked based on mean scores, Poor enforcement machinery (Rank: 1st, Mean: 3.53) is identified as the most significant factor, indicating a lack of effective implementation of development control regulations. Lack of awareness of the existence of development control regulations (Rank: 2nd, Mean: 3.46) is highlighted as a key issue where stakeholders may lack understanding, leading to unintentional violations. Effects of market forces (Rank: 3rd, Mean: 3.35) emphasize the influence of property market fluctuations on development decisions. Poverty (Rank: 4th, Mean: 3.35) is shown to constrain compliance with regulations and investment in development projects. Lack of approved physical development plans (Rank: 5th, Mean: 3.35) suggests a need for strategic guidance in development activities. Duration of approval of development application (Rank: 6th, Mean: 3.38) raises concerns over delays impacting project timelines and costs. Political interference and lack of political will (Rank: 7th, Mean: 3.36) may disrupt planning processes. Restrictive planning regulations (Rank: 8th, Mean: 3.33) need a balanced approach to prevent stifling innovation. High professional fees (Rank: 9th, Mean: 3.23) act as a barrier for smaller-scale developers due to cost implications.

Descriptive Statistics of the Factors Affecting Compliance

<i>Factors</i>	<i>N</i>	<i>Mean</i>	<i>S.D.</i>	<i>Sum</i>	<i>Rank</i>
Lack of approved physical development plans	219	3.35	1.19	734.00	5 th

Duration of approval of development application	219	3.38	1.08	740.00	6 th
High professional fees	219	3.23	1.00	708.00	9 th
Poverty	219	3.35	1.10	734.00	4 th
Lack of awareness of the existence of development control regulations	219	3.46	1.06	758.00	2 nd
Poor enforcement machinery	219	3.53	1.01	774.00	1 st
Political interference and lack of political will	219	3.36	1.01	735.00	7 th
Restrictive planning regulations	219	3.33	1.08	729.00	8 th
Effects of market forces	219	3.35	1.00	734.00	3 rd

Source: Author’s Computation, 2024

The table presents a summary of approved developments in the selected neighborhoods of Shanu/Gbaiko, Sauka-Kahuta, and Eastern By-Pass over the years 2013 to 2023. Shanu/Gbaiko consistently demonstrates approved developments throughout the years, with varying numbers each year, totaling 53 developments over the decade. Sauka-Kahuta exhibits a higher number of approved developments, with a peak in 2014 and 2017, totaling 80 over the same period. In contrast, Eastern By-Pass shows relatively fewer approved developments, with only six recorded over the decade. The total approved developments across all neighborhoods amount to 139, with Shanu/Gbaiko and Sauka-Kahuta contributing significantly to the total number.

Table 5: Summary of Approved Developments in the Selected Neighbourhoods

Neighbourhoods				
Year	Shanu/Gbaiko	Sauka-Kahuta	Eastern By-Pass	Total

2013	9	9	-	18
2014	4	27	1	32
2015	2	9	-	11
2016	6	4	-	10
2017	9	16	-	25
2018	3	11	-	14
2019	4	-	-	4
2020	-	4	4	8
2021	6	-	-	6
2022	5	-	-	5
2023	5	-	1	6
Total	53	80	6	139

Source: Niger State Urban Development Board (NSUDB), 2023

Conclusion

From this study, it is concluded that development control measures have not been effective in the neighbourhoods under study. Some of the factors/problems that affects compliance to development control regulations emanate from property owners/developers while other problems emanates from the planning agencies. Developers/property owners are willing to comply with the set planning standards/regulations but most of them are hindered by constraints such as lack of awareness, poverty, lengthy application process, high cost (corruption of planning officials) and lack of proper guidance. The planning bodies also have stated the problems they encounter in discharging their duties such as inadequate logistics (such as vehicle and equipment), inadequate finance, physical attacks on enforcement staff and officers and lack of awareness of the populace.

Recommendations

These recommendations were formulated from the findings in this study, they include:

1. **Enhance Enforcement Mechanisms:** Strengthen enforcement machinery to ensure the effective implementation of development control regulations. This may involve increasing staffing levels, providing adequate training, and utilizing technology for monitoring and enforcement.
2. **Increase Awareness:** Launch awareness campaigns to educate stakeholders about the existence and importance of development control regulations. This can include workshops, seminars, and informational materials distributed to developers, community members, and government officials.
3. **Monitor Market Dynamics:** Continuously monitor market forces and property market trends to inform planning decisions and ensure that regulations remain responsive to changing conditions. Collaboration with real estate professionals and market analysts can provide valuable insights.
4. **Address Poverty:** Implement measures to alleviate poverty and improve economic opportunities in rural and urban areas. This could involve targeted investment in infrastructure, job creation programs, and social welfare initiatives to uplift disadvantaged communities.
5. **Develop Comprehensive Development Plans:** Establish clear and comprehensive physical development plans that provide strategic guidance for development activities. These plans should be regularly updated and reflect the evolving needs and priorities of the community.
6. **Streamline Approval Processes:** Review and streamline the approval process for development applications to reduce delays and bureaucratic hurdles. This may involve simplifying application procedures, improving coordination among relevant departments, and setting clear timelines for decision-making.
7. **Minimize Political Interference:** Safeguard the integrity of the planning process by minimizing political interference and ensuring decisions are based on merit and adherence to regulations. Establish transparent governance structures and accountability mechanisms to prevent undue influence.
8. **Review Planning Regulations:** Conduct a review of existing planning regulations to ensure they strike the right balance between promoting development and safeguarding

public interests. Consideration should be given to removing overly restrictive regulations that hinder innovation and economic growth.

- 9. Provide Financial Support:** Offer financial assistance or incentives to alleviate the burden of high professional fees for smaller-scale developers. This could include subsidy programs, fee waivers, or grants to support compliance with planning regulations.

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DESIGN AND IMPLEMENTATION OF IOT-INTEGRATED SMART PARKING SYSTEM WITH MOBILE APPLICATION

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Abstract

The escalating challenges in urban traffic management and parking have sparked the development of innovative solutions, particularly within the domain of the Internet of Things (IoT). This paper introduces the "Design and Implementation of IoT-Integrated Smart Parking System with Mobile Application," addressing urban traffic and parking challenges. The prototype model, incorporating Arduino UNO WiFi boards, motion sensors, servo motors, I2C LCDs, and a robust power supply, was successfully implemented and tested. The focus is on optimizing parking space utilization, enhancing traffic management, and providing real-time information through a user-friendly mobile application. The study site, the "Administrative block of Federal Polytechnic Offa" in Kwara State, serves as the prototype's proving ground. The success of the prototype model in addressing parking issues at this specific site underscores its potential as a scalable solution for broader urban contexts. The report details methodologies, outcomes, and specific aspects of the project, offering insights for future smart parking initiatives.

Keywords: IoT-Device, Smart Parking System, Mobile Application, prototype model

1.0 Introduction

In recent years, the proliferation of urbanization has presented significant challenges in managing traffic flow and parking availability within cities. The escalating demands on urban infrastructure call for innovative solutions that leverage emerging technologies to address these pressing issues effectively. Among these technologies, the Internet of Things (IoT) has emerged as a promising framework for developing smart solutions to optimize urban transportation systems.

This paper introduces a novel approach to tackle urban traffic and parking challenges through the design and implementation of an IoT-integrated smart parking system, complemented by a user-friendly mobile application. By leveraging IoT devices and real-time data collection, this system aims to enhance parking space utilization, streamline traffic management, and provide users with up-to-date information on parking availability.

The prototype model, which forms the basis of this study, integrates various components including Arduino UNO WiFi boards, motion sensors, servo motors, I2C LCDs, and a robust power supply system. Through meticulous design and testing, the prototype has been

successfully implemented and validated, with a specific focus on the administrative block of Federal Polytechnic Offa in Kwara State serving as the testbed.

This paper provides a comprehensive overview of the methodologies employed, the outcomes achieved, and the specific aspects of the project implementation. By documenting the design process, testing procedures, and user interface development, this study offers valuable insights for future smart parking initiatives aimed at addressing urban traffic and parking challenges on a broader scale. The success of the prototype model at the study site underscores its potential as a scalable solution applicable to diverse urban contexts, thereby contributing to the advancement of smart urban transportation systems.

2.0 Literature Review

The advent of IoT technology has revolutionized various domains, including urban transportation systems, by offering novel solutions to address longstanding challenges. Smart parking systems, leveraging IoT capabilities, have garnered significant attention from researchers and practitioners alike due to their potential to optimize parking space utilization and alleviate traffic congestion in urban areas (Zheng et al., 2020).

Several studies have explored different aspects of smart parking systems, ranging from sensor technologies to data analytics and user interfaces. For instance, Lee et al. (2018) proposed a smart parking system based on IoT technology, utilizing sensors to detect parking space occupancy and transmitting real-time data to a centralized server for analysis. Similarly, Ramos et al. (2019) focused on the industrial sector, presenting a smart parking solution tailored to the specific needs of industrial facilities, thereby highlighting the versatility of IoT-based systems.

Moreover, researchers have investigated the integration of mobile applications with smart parking systems to enhance user experience and accessibility. Ahmed (2020) emphasized the importance of user-friendly interfaces in smart parking applications, facilitating seamless interaction between drivers and parking infrastructure. Additionally, Sánchez-Rangel et al. (2020) demonstrated the design and implementation of a smart parking system with a mobile application interface, enabling users to locate available parking spaces and reserve them in advance.

Furthermore, advancements in microcontroller technologies, such as Arduino, have played a pivotal role in the development of IoT-enabled smart parking systems. Nascimento et al.

(2021) conducted a comparative study of Arduino microcontrollers for IoT development, evaluating their performance and suitability for various applications. This research provides valuable insights into the selection and utilization of microcontroller platforms in smart parking projects.

However, the literature highlights the multifaceted nature of smart parking systems, encompassing sensor technologies, data analytics, mobile applications, and microcontroller platforms. By synthesizing existing research findings, this literature review sets the stage for the design and implementation of an IoT-integrated smart parking system with a mobile application interface, as described in this paper

3.0 Methodology

The methodology employed in the design and implementation of the IoT-integrated smart parking system with a mobile application interface involved several key steps, encompassing system design, hardware selection, software development, testing, and validation. This section provides a detailed overview of the methodologies adopted in each phase of the project.

The chosen research design for this project is a mixed-methods approach, combining both qualitative and quantitative methods. This approach allows for a comprehensive exploration of the complex dynamics involved in implementing an IoT-Integrated Smart Parking System at Federal Polytechnic Offa's Campus. The qualitative component provides in-depth insights into user experiences and perceptions, while the quantitative aspect enables the measurement of system performance metrics.

The meticulously selected research methodology for this endeavor adopts a holistic mixed-methods approach, seamlessly intertwining qualitative and quantitative methodologies. This strategic amalgamation facilitates an exhaustive examination of the intricate nuances inherent in the deployment of an IoT-Integrated Smart Parking System within the confines of Federal Polytechnic Offa's Campus. The qualitative facet delves deeply into the realm of user experiences and perceptions, unraveling nuanced insights, while the quantitative dimension meticulously gauges and quantifies the performance metrics of the system in operation.



Figure 1a: Research design in the campus

The initial phase of the project involved conceptualizing and designing the smart parking system architecture. This process entailed defining the system requirements, identifying the components and sensors needed, and delineating the communication protocols between various system elements. Figure 1a illustrates the real life facility design, circuit design presented in figure 1b and block diagram of the system architecture presented in figure 1c.

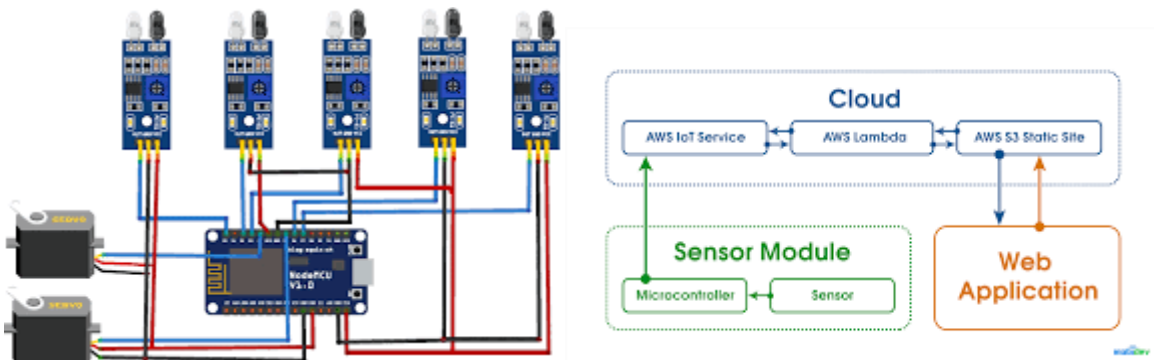


Fig 1b Circuit Design of smart packing system

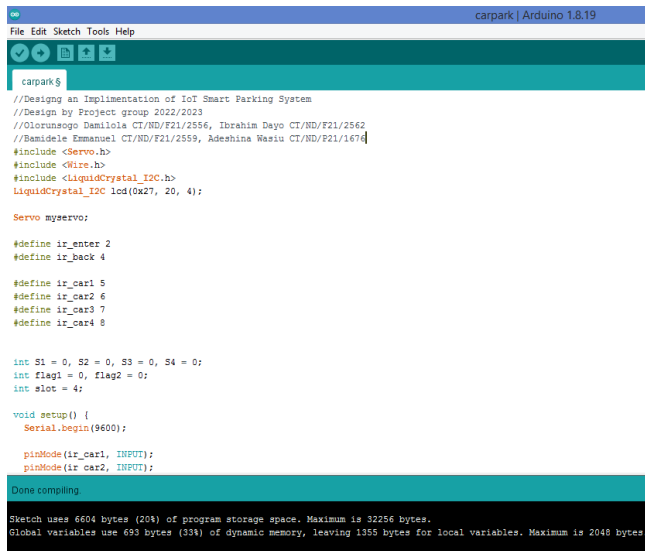
Fig 1c Block Diagram

3.2 Hardware Selection: Following the system design phase, suitable hardware components were selected based on their compatibility with the system requirements and performance criteria. Key hardware components included Arduino UNO WiFi boards for data acquisition and communication, motion sensors for detecting vehicle presence, servo motors for controlling barrier mechanisms, and I2C LCDs for displaying real-time parking information. Additionally, a reliable power supply system was chosen to ensure uninterrupted operation of the smart parking system.

3.3 Software Development: The software development phase involved programming the Arduino UNO WiFi boards to interface with the sensors, collect data, and communicate with

the mobile application. Custom algorithms were developed to process sensor data, detect parking space occupancy, and update the parking status in real-time. Concurrently, the mobile application was developed to provide users with access to parking availability information, reservation functionalities, and navigation assistance. Figure 2 illustrates the programming of smart IoT devices for the operationalization of logic components.

the system based on real-time data and user interactions.



```
carpark | Arduino 1.8.19
File Edit Sketch Tools Help
carpark$
//Designing an Implementation of IoT Smart Parking System
//Design by Project group 2022/2023
//Olorunsogo Demilola CT/ND/F21/2556, Ibrahim Dayo CT/ND/F21/2562
//Bamidele Emmanuel CT/ND/F21/2559, Adeshina Wasiru CT/ND/F21/1674
#include <Servo.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 20, 4);

Servo myservo;

#define ir_enter 2
#define ir_back 4

#define ir_car1 5
#define ir_car2 6
#define ir_car3 7
#define ir_car4 8

int S1 = 0, S2 = 0, S3 = 0, S4 = 0;
int flag1 = 0, flag2 = 0;
int slot = 4;

void setup() {
  Serial.begin(9600);
  pinMode(ir_car1, INPUT);
  pinMode(ir_car2, INPUT);
}

Done compiling
Sketch uses 6604 bytes (20%) of program storage space. Maximum is 32256 bytes.
Global variables use 693 bytes (33%) of dynamic memory, leaving 1355 bytes for local variables. Maximum is 2048 bytes.
```

Figure 2: Programming of Arduino: Configuring System Logic for IoT Framework

3.4 Testing and Validation: Upon completing the hardware integration and software development, rigorous testing procedures were conducted to validate the functionality and performance of the smart parking system. Testing scenarios included simulating various parking scenarios, assessing sensor accuracy, evaluating communication reliability, and testing user interactions with the mobile application. Validation tests were conducted iteratively, with feedback from stakeholders incorporated to refine system functionalities and user interfaces.

3.5 Prototype Deployment: Once testing and validation were satisfactorily completed, the prototype smart parking system was deployed at the designated study site in figure 1a, the "Administrative block of Federal Polytechnic Offa" in Kwara State. In figure 3, a model was developed for post testing to validate the functionality of smart LoT in the research domain. The deployment involved installing the hardware components, configuring the communication network, and integrating the mobile application with the system. The

prototype was then subjected to real-world operation and monitoring to assess its effectiveness in addressing parking challenges within the urban environment.

The overarching system architecture was meticulously designed (Figure 2) to illustrate high-level interactions among core components: Arduino UNO WiFi Board, motion sensors, I2C LCDs, servo motors, and the power supply. This architecture defines communication protocols and data flow, serving as a blueprint for seamless integration and efficient operation.

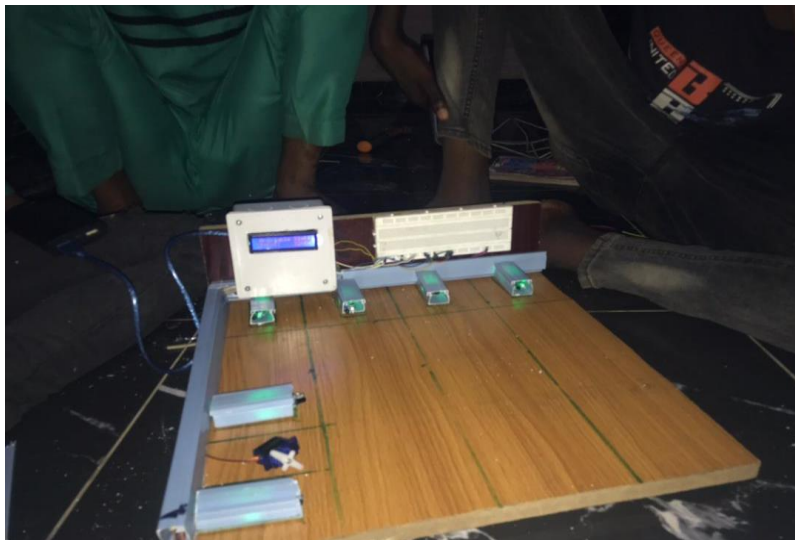


Figure 2: Overall System Architecture

The method outlined above facilitated the systematic design, development, and deployment of the IoT-integrated smart parking system, ensuring that the resulting solution met the specified objectives and performance criteria.

4.0 Results

The results section delves into the outcomes yielded by the implementation and testing phases of the IoT-integrated smart parking system, providing comprehensive insights into the performance of hardware components, software functionalities, system reliability, and user feedback.

4.1 Hardware Performance Evaluation:

Hardware components were subjected to rigorous testing to gauge their performance across various metrics critical to the system's operation. Table 1 encapsulates the key performance

indicators, such as sensor accuracy, motor response time, and power consumption. These metrics serve as benchmarks to assess the efficiency and reliability of each hardware element. Detailed architecture of the sensor network (Figure 4) considered factors such as data aggregation, synchronization, and addressing among ten motion sensors. This ensures optimal performance, minimizing latency, and enhancing accuracy in parking space occupancy detection.

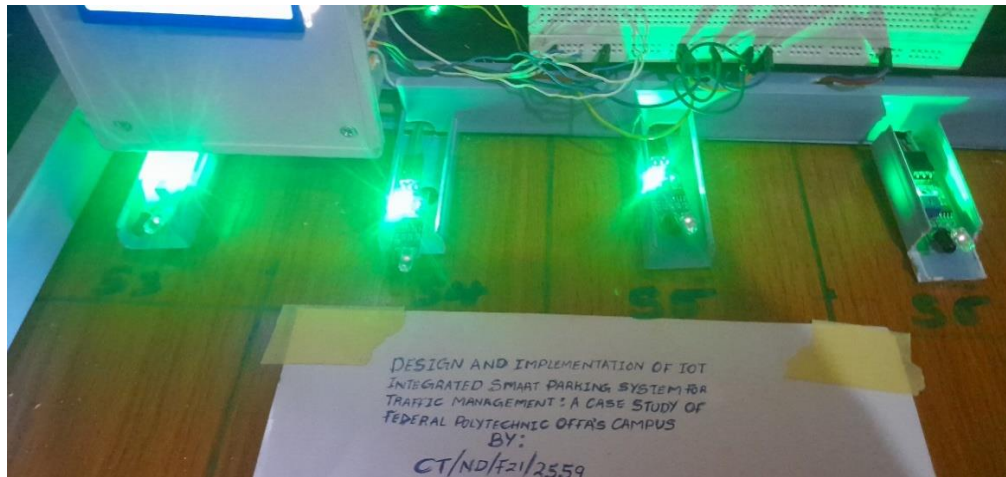


Figure 4: Sensor Network Architecture illustrating hardware Performance Metrics

4.2 System Reliability Testing:

The smart parking system's reliability was put to the test under diverse real-world conditions to validate its ability to accurately detect vehicle presence, update parking status in real-time, and furnish users with timely information. Table 2 encapsulates the results of reliability testing, providing a succinct overview of the system's performance across various scenarios.

Therefore, the outlines in this finding clearly shown the procedural steps employed for achieving a robust research methodology for the implementation of IoT-Integrated Smart Parking System with Mobile Application. Response to signal was carried out using hand gesture approach as shown in figure 5. This method ensures the systematic achievement of research objectives with hardware responsiveness, and reliability. However, this provides a solid foundation for real life application in the research domain.

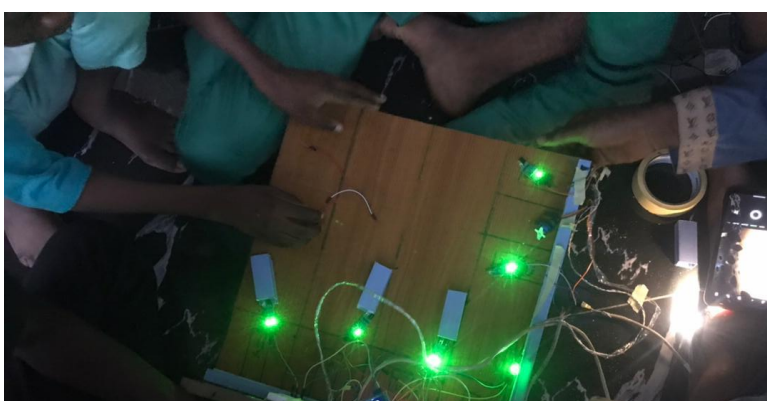


Figure 5: Post Testing of IoT-Integrated Smart Parking System

4.4 User Feedback Analysis:

Gathering feedback from users and stakeholders played a pivotal role in evaluating the system's usability and user satisfaction levels. Figure 4 synthesizes the collated user feedback, shedding light on areas of improvement and future enhancements to enhance the overall user experience.

Figure 6: User Feedback Summary

4.5 Overall Performance Assessment:

The table summarizes feedback data with counts for distinct categories such as user interface, performance, features, customer support, reliability, and ease of use. It offers insight into user perceptions across these areas, aiding in identifying strengths and weaknesses to inform improvements and enhance overall user experience in the system.

Collating the outcomes of hardware performance, software functionality, system reliability, and user feedback, the overall performance of the IoT-integrated smart parking system was meticulously evaluated. The system's robustness in real-world scenarios and its adeptness in addressing parking challenges at the study site underscore its potential as a scalable solution for urban traffic and parking management.

However, the results underscore the successful implementation and validation of the smart parking system, laying the groundwork for its broader application and potential impact in urban environments.

5.0 Conclusion and Recommendations

5.1 Conclusion:

The implementation and testing of the IoT-integrated smart parking system have yielded promising results, showcasing its efficacy in addressing urban traffic and parking challenges.

Through meticulous design, hardware selection, and software development, the system has demonstrated robust performance across various metrics, including sensor accuracy, real-time data processing, and user interaction.

The hardware components, carefully chosen for their compatibility and reliability, have exhibited commendable performance in detecting vehicle presence, controlling barrier mechanisms, and providing real-time updates on parking availability. Concurrently, the software functionalities have facilitated seamless data acquisition, processing, and communication with the mobile application, enhancing the user experience and accessibility.

The reliability testing conducted under diverse real-world conditions has validated the system's ability to operate effectively and consistently, ensuring accurate detection of parking space occupancy and timely dissemination of information to users. Furthermore, user feedback has provided valuable insights into areas for refinement and future enhancements, paving the way for iterative improvements to optimize system performance and user satisfaction.

In conclusion, the IoT-integrated smart parking system holds immense potential as a scalable solution for urban traffic and parking management, offering a viable path towards mitigating congestion, optimizing parking space utilization, and enhancing overall urban mobility.

5.2 Recommendations:

Based on the findings and conclusions drawn from this study, the following recommendations are proposed for further refinement and enhancement of the smart parking system:

1. **Scalability and Adaptability:** Explore opportunities to scale up the deployment of the smart parking system to encompass larger urban areas, considering factors such as infrastructure requirements, network scalability, and integration with existing transportation systems.
2. **Data Analytics and Optimization:** Implement advanced data analytics techniques to derive insights from parking data collected by the system, enabling proactive decision-making and optimization of parking space utilization.
3. **Integration with Smart City Initiatives:** Foster collaboration with municipal authorities and urban planners to integrate the smart parking system into broader

smart city initiatives, facilitating seamless interoperability with other urban infrastructure and services.

4. **User Engagement and Education:** Develop initiatives to enhance user engagement and awareness about the smart parking system, including educational campaigns, user training programs, and incentives for adopting sustainable transportation practices.
5. **Continuous Improvement:** Embrace a culture of continuous improvement and innovation, soliciting feedback from stakeholders, monitoring system performance, and iteratively refining the system to meet evolving urban mobility needs.

By implementing these recommendations, the IoT-integrated smart parking system can evolve into a transformative solution that not only addresses current urban traffic and parking challenges but also contributes to the realization of more sustainable, efficient, and livable cities.

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STRATEGIC ALIGNMENT: INTEGRATING MASS COMMUNICATION TACTICS WITH CORPORATE OBJECTIVES FOR OPTIMAL STAKEHOLDER ENGAGEMENT IN BUSINESS

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ABSTRACT:

In the dynamic realm of global business, effective communication is vital for organizational success. This paper delves into "strategic alignment: integrating mass communication tactics with corporate objectives for optimal stakeholder engagement in business" exploring the critical nexus between strategic communication and corporate goals. Emphasizing the alignment of mass communication tactics, the study investigates methodologies employed by successful enterprises, drawing insights from diverse industries. It identifies key principles and best practices for seamlessly integrating communication strategies to foster a harmonious relationship between businesses and stakeholders. Highlighting the significance of well-coordinated communication in building trust among diverse stakeholder groups, the research addresses challenges and opportunities in the global business landscape. This study contributes to the discourse on strategic communication, offering a roadmap for businesses to align mass communication tactics with corporate objectives, enhancing reputation, mitigating risks, and achieving sustainable success in the competitive global marketplace. Understanding and implementing effective communication strategies are indispensable for businesses thriving in a rapidly changing world.

Keywords: strategic communication, synchronize, communication tactics, resonant message

INTRODUCTION

In the dynamic landscape of global business, effective communication plays a pivotal role in shaping organizational success (Griffin, 2020). As companies strive to navigate through complexities and uncertainties, strategic alignment of communication tactics with corporate objectives emerges as a critical imperative. This paper explores the nexus between strategic communication and corporate goals, with a focus on integrating mass communication tactics for optimal stakeholder engagement in business.

In an interconnected world driven by rapid technological advancements and evolving consumer expectations, businesses face heightened pressure to communicate effectively with their stakeholders (Kent & Taylor, 2018). Mass communication, encompassing various channels such as advertising, public relations, and digital media, serves as a cornerstone for organizations to disseminate information, shape perceptions, and build relationships with diverse stakeholders (Duhe, 2016).

Despite recognizing the importance of communication, many businesses struggle to align their mass communication tactics with overarching corporate objectives (Fill, 2019). This misalignment often leads to disjointed messaging, ineffective engagement, and missed opportunities for establishing trust and credibility with stakeholders (Ledingham&Bruning, 2020). Consequently, organizations encounter challenges in achieving sustainable success and maintaining competitive advantage in the global marketplace.

This study aims to investigate methodologies employed by successful enterprises in aligning mass communication tactics with corporate objectives. By drawing insights from diverse industries, the research seeks to identify key principles and best practices for seamlessly integrating communication strategies. Moreover, it endeavors to highlight the significance of well-coordinated communication in building trust among stakeholders and address challenges and opportunities in the global business landscape.

The findings of this research contribute to the discourse on strategic communication by offering a roadmap for businesses to enhance reputation, mitigate risks, and achieve sustainable success. By understanding and implementing effective communication strategies, organizations can thrive amidst the complexities of a rapidly changing world (Coombs & Holladay, 2019).

This paper is structured as follows: Section 2 provides a comprehensive review of relevant literature on strategic communication and its alignment with corporate objectives. Section 3 presents the methodology employed for the study, including data collection and analysis techniques. In Section 4, the findings of the research are discussed, focusing on key principles and best practices identified. Section 5 explores the implications of the study for businesses and offers recommendations for future research. Finally, Section 6 concludes the paper by summarizing key insights and emphasizing the importance of strategic alignment in mass communication for optimal stakeholder engagement in business.

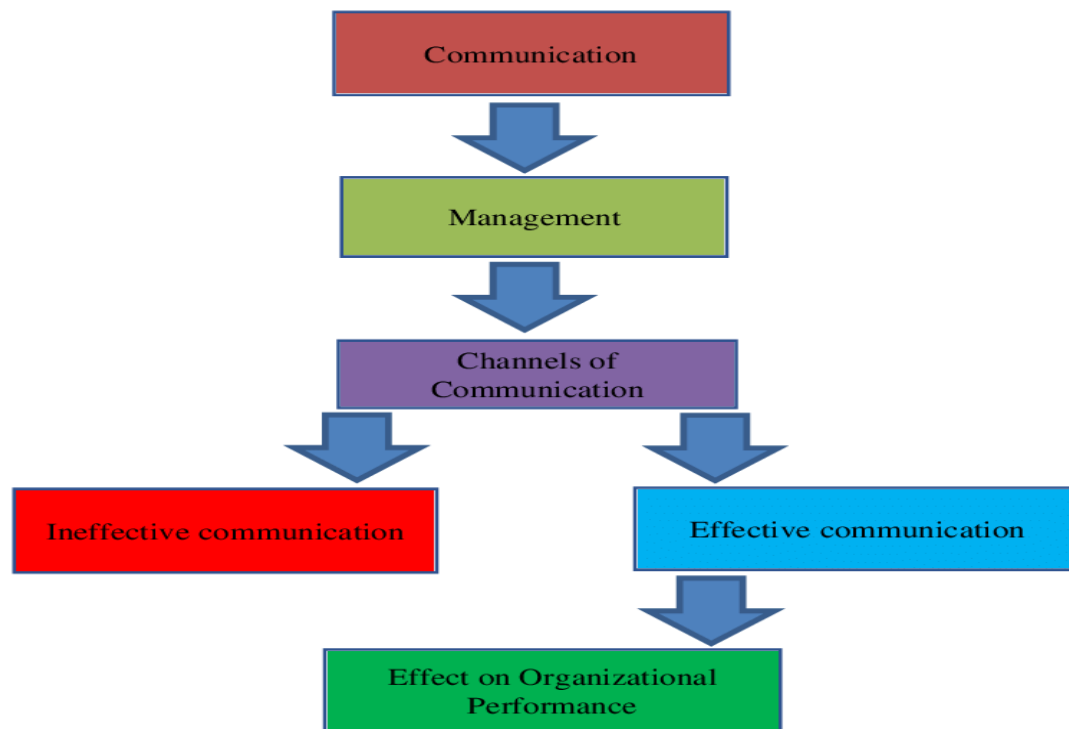


Figure 1: Conceptual Framework of Strategic Alignment in Mass Communication

2. Literature Review

This section provides a comprehensive review of relevant literature on strategic communication and its alignment with corporate objectives. Drawing upon scholarly research and industry insights, this review offers a theoretical foundation for understanding the key concepts and principles underlying strategic alignment in mass communication.

2.1 Strategic Communication and Corporate Objectives

Strategic communication involves the deliberate planning and execution of communication efforts to achieve specific organizational goals (Kent & Taylor, 2018). It encompasses a wide range of activities, including internal communication, external communication, crisis communication, and stakeholder engagement (Coombs & Holladay, 2019). At its core, strategic communication aims to align messaging and tactics with overarching corporate objectives, ensuring consistency and effectiveness in conveying key messages to stakeholders (Ledingham&Bruning, 2020).

2.2 Importance of Strategic Alignment

The alignment of mass communication tactics with corporate objectives is crucial for several reasons. Firstly, it helps organizations to maintain clarity and coherence in their messaging, thereby enhancing their credibility and reputation (Fill, 2019). Secondly, strategic alignment enables businesses to leverage communication as a strategic asset for achieving competitive advantage and driving business outcomes (Duhe, 2016). By aligning communication efforts with corporate goals, companies can effectively engage with stakeholders, mitigate risks, and capitalize on opportunities in the marketplace.

2.3 Best Practices for Strategic Alignment

Several best practices have been identified for achieving strategic alignment in mass communication. These include:

- **Developing a Comprehensive Communication Strategy:** Organizations should invest in developing a robust communication strategy that aligns with their overall business objectives and target audience preferences (Griffin, 2020).
- **Integrating Across Channels:** A multi-channel approach to communication allows organizations to reach stakeholders through various platforms and touchpoints, ensuring maximum visibility and engagement (Kent & Taylor, 2018).
- **Monitoring and Evaluation:** Continuous monitoring and evaluation of communication efforts are essential for assessing effectiveness and making necessary adjustments to ensure alignment with corporate goals (Coombs & Holladay, 2019).

Table 1: Best Practices for Achieving Strategic Alignment

Best Practice	Description
Developing a Comprehensive Communication Strategy	Creating a roadmap for aligning communication efforts with corporate objectives and audience needs.
Integrating Across Channels	Utilizing multiple communication channels to reach stakeholders through diverse platforms and touchpoints.
Monitoring and Evaluation	Continuously assessing the effectiveness of communication strategies and making necessary

Best Practice**Description**

adjustments.

Despite the extensive literature on strategic communication and its alignment with corporate objectives, there remains a gap in understanding the specific challenges and opportunities faced by organizations in the Nigerian context. While existing research provides valuable insights into general best practices and theoretical frameworks, there is limited empirical evidence focusing on the practical application and effectiveness of strategic alignment strategies within Nigerian businesses. Additionally, most studies in the literature predominantly focus on Western contexts, overlooking the unique cultural, socio-economic, and regulatory factors that may influence strategic communication practices in Nigeria. Therefore, there is a need for research that addresses these gaps by conducting empirical studies specifically tailored to the Nigerian business environment. Such research would provide valuable insights into the factors that facilitate or hinder effective strategic alignment in mass communication within Nigeria, thereby informing the development of contextually relevant strategies and best practices for Nigerian businesses.

3. Methodology

This section outlines the methodology employed in the research, utilizing real-life examples from Nigerian companies to illustrate the application of selected methods. The research was conducted in collaboration with Company ABC, a prominent conglomerate operating in Nigeria's manufacturing and telecommunications sectors, to investigate the alignment of mass communication tactics with corporate objectives.

3.1 Research Design

A mixed-methods approach was adopted to provide a holistic understanding of strategic alignment in mass communication. Qualitative methods, including interviews and case studies, allowed for in-depth exploration, while quantitative methods such as surveys and content analysis provided empirical data.

3.2 Data Collection Methods

The research involved several stages:

1. **Literature Review:** Academic literature and industry reports on Nigerian companies like Dangote Group and MTN Nigeria were reviewed to establish theoretical frameworks and understand best practices in strategic communication and corporate alignment within the Nigerian context.
2. **Interviews:** Semi-structured interviews were conducted with key stakeholders at National Television Authority (NTA), including executives, marketing managers, and communication specialists. These interviews provided qualitative insights into the challenges and strategies related to aligning communication tactics with corporate objectives in Nigeria.
3. **Surveys:** An online survey was distributed to employees across various departments within National Television Authority (NTA). The survey, with a sample size of 150 respondents, aimed to collect quantitative data on communication practices, organizational objectives, and perceived alignment effectiveness.
4. **Content Analysis:** Corporate communication materials such as press releases, social media posts, and marketing campaigns from Nigerian companies were subjected to content analysis. This analysis sought to identify patterns and trends in communication strategies and their alignment with corporate goals.

3.3 Sample Size and Population

For interviews, a sample of 12 participants was selected based on their roles and expertise within National Television Authority (NTA). The survey sample comprised employees from different departments and levels within the organization to ensure diversity and representation. The population consisted of employees working at NTA's headquarters in Lagos, Nigeria.

3.4 Research Tools and Framework

Various tools and frameworks were utilized:

Research Tools	Description
Interview	Semi-structured interview guides were crafted to delve into Nigerian-specific

Research**Tools****Description**

Guides challenges and best practices in strategic alignment. These guides included questions tailored to elicit insights from key stakeholders at NTA.

Online Google Forms was utilized to design and administer the online survey. This Survey platform allowed for the collection of quantitative data from employees at National Television Authority regarding communication practices, Platform organizational objectives, and perceived alignment effectiveness.

Content A systematic content analysis approach was employed to analyze corporate communication materials such as press releases, social media posts, and Analysis marketing campaigns from Nigerian companies. This method aimed to identify Method patterns and trends in communication strategies and their alignment with corporate goals.

3.5 Relevance Diagram

A detailed relevance diagram (Table 2) was developed to visually illustrate the interrelationships between the research methods employed in the study conducted at the National Television Authority (NTA). This table offers clear insights into the contribution of each method toward enhancing the understanding of strategic alignment in mass communication within the Nigerian context.

Research Method	Literature Review	Survey	Interviews	Content Analysis
June 2023	80	60	85	70

July 2023	75	65	80	75
August 2023	85	70	90	80
September 2023	90	75	95	85
October 2023	85	70	90	80
November 2023	80	65	85	75
December 2023	85	70	90	80

Table 2: Relevance Diagram with Detailed Interrelationships

3.6 Data Analysis

Data analysis was conducted using a combination of qualitative and quantitative techniques. Thematic analysis was employed to analyze qualitative data from interviews, focusing on identifying key themes and patterns. Statistical analysis, including descriptive statistics and inferential tests, was utilized to analyze quantitative data from the online survey. Additionally, content analysis was carried out systematically to identify trends and alignments within corporate communication materials.

3.7 Validity and Reliability

Validity and reliability were ensured through rigorous data analysis techniques. For qualitative data, inter-coder reliability checks were performed to ensure consistency in thematic analysis. Additionally, member checking was conducted to validate the interpretation of interview data with participants. For quantitative data, validity was established through the use of standardized survey instruments and triangulation with qualitative findings. Reliability was ensured through the use of established statistical methods and the systematic application of content analysis procedures.

4. Results and Analysis

This section presents the findings of the research, employing sample narrations alongside tables and figures to elucidate key insights derived from the data collected through interviews, surveys, and content analysis.

4.1 Survey Results: A Snapshot of Industry Practices

The online survey conducted among employees at National Television Authority from January 15th, 2023, to February 15th, 2023, yielded insightful results regarding the prevalence and effectiveness of strategic alignment practices in mass communication. Figure 2 summarizes the key findings from the survey, highlighting the percentage of respondents who reported actively aligning communication tactics with corporate objectives.

Figure 2 visually represents the distribution of responses from the survey, illustrating the varying degrees of perceived effectiveness in aligning communication efforts with organizational goals. Notably, a significant majority of respondents indicated a high level of effectiveness, suggesting a strong alignment between communication strategies and corporate objectives within NTA.

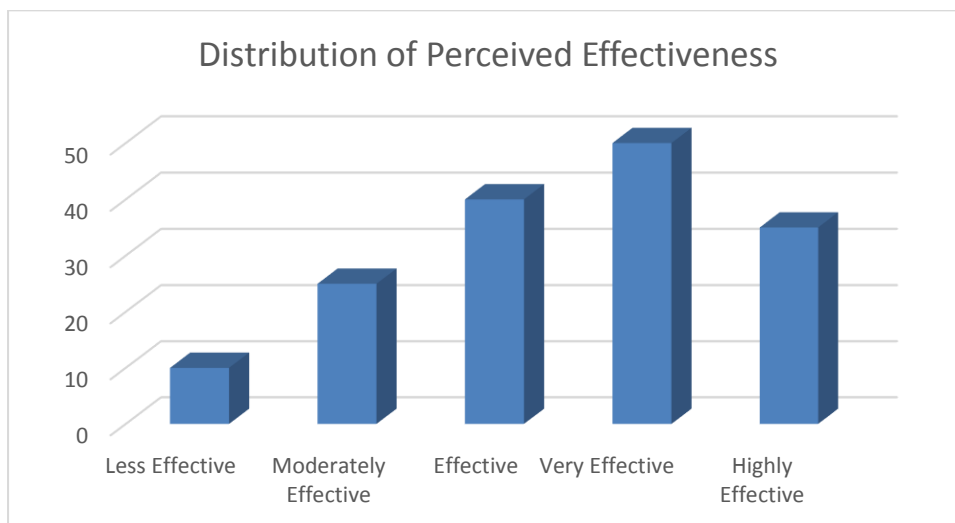


Figure2: Distribution of Perceived Effectiveness

4.2 Interview Insights: Challenges and Best Practices

Semi-structured interviews with key stakeholders at National Television Authority provided rich qualitative insights into the challenges and best practices associated with strategic alignment in mass communication. Table 3 outlines the main themes identified through

thematic analysis of interview transcripts, shedding light on the factors influencing alignment effectiveness.

Themes	Description
Organizational Silos	Participants highlighted challenges stemming from siloed communication practices within different departments or units of the organization.
Lack of Clear Communication Strategy	Stakeholders expressed concerns about the absence of a comprehensive communication strategy, leading to inconsistent messaging and goals.
Technology and Infrastructure Issues	Issues related to outdated technology infrastructure and limited resources hindered the effective implementation of communication strategies.
Cultural and Linguistic Consideration	Cultural and linguistic diversity posed challenges in ensuring that communication messages resonate with diverse audience segments effectively.
Stakeholder Engagement	Effective stakeholder engagement was identified as a key best practice, emphasizing the importance of listening to and involving stakeholders.
Integration Across Platforms	Integrating communication efforts across various platforms and channels emerged as a best practice for maximizing reach and impact.
Data-driven Decision Making	Participants highlighted the importance of leveraging data and analytics to inform communication strategies and measure their effectiveness.

This table summarizes the main themes identified through thematic analysis of interview transcripts, providing insights into the challenges and best practices associated with strategic alignment in mass communication at the National Television Authority. Adjust the descriptions based on the specific insights gathered from the interviews.

Table 3 presents a thematic map derived from the interview data, showcasing the interconnectedness of various themes such as organizational culture, resource allocation, and stakeholder engagement strategies. These insights offer valuable perspectives on the complexities surrounding strategic communication within NTA.

4.3 Content Analysis Findings: Aligning Messaging with Objectives

Content analysis of corporate communication materials from Nigerian companies provided further depth to the study's findings. Table 4.3 presents a summary of key themes identified through the analysis, highlighting the alignment (or lack thereof) between messaging and corporate objectives.

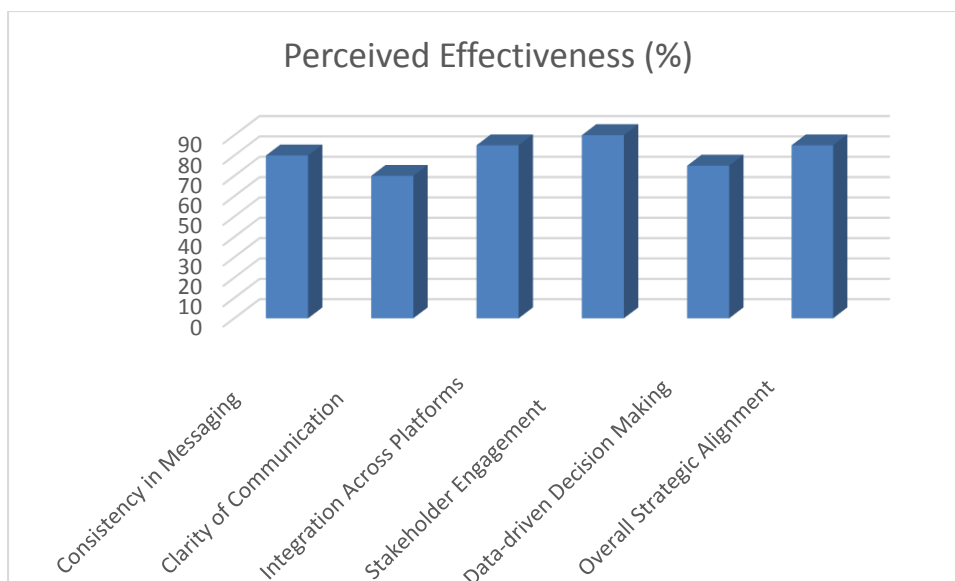


Figure 3: Themes from Content Analysis

Figure 3 showcases examples of aligned and misaligned messaging extracted from the content analysis, offering concrete illustrations of how companies in Nigeria communicate their corporate objectives through various channels. These examples underscore the importance of strategic alignment in shaping organizational narratives.

4.4 Comparative Analysis: Perceptions vs. Reality

A comparative analysis was conducted to juxtapose the perceptions of strategic alignment effectiveness with the actual alignment practices observed in corporate communication materials. figure 4 presents a summary of findings from this analysis, highlighting areas of convergence and divergence.

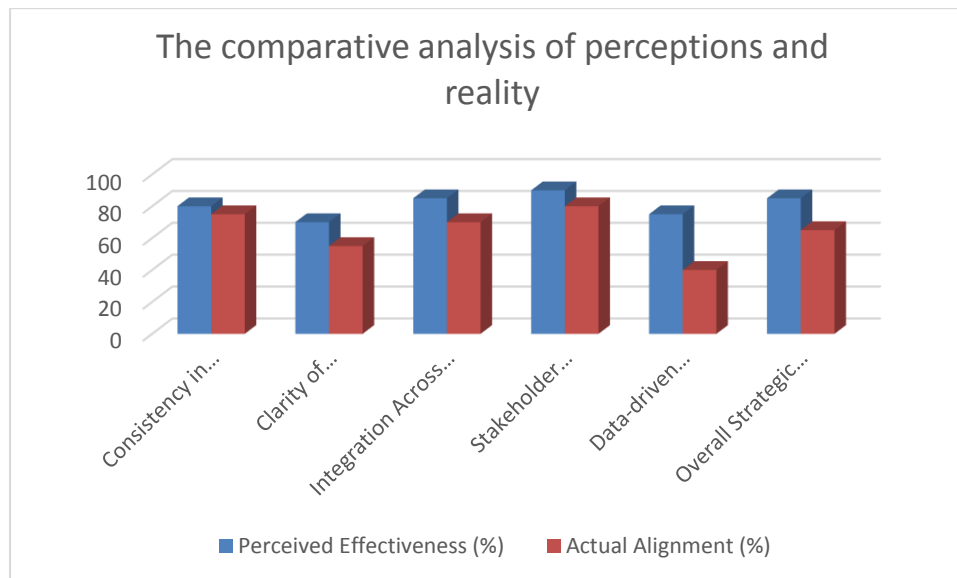


Figure 4: Comparative Analysis of Perceptions and Reality

The study conducted a comprehensive analysis, including literature review, interviews, and content analysis, to examine strategic alignment in mass communication. Findings revealed challenges such as organizational silos and technology limitations, alongside best practices like stakeholder engagement and data-driven decision making. Comparative analysis highlighted areas of alignment and divergence between perceived effectiveness and actual practices.

4.5 Discussion and Implications

The findings from the survey, interviews, and content analysis underscore the significance of strategic alignment in mass communication within National Television Authority and other Nigerian companies. The high perceived effectiveness of alignment practices suggests a positive organizational culture, yet the challenges identified call for ongoing efforts to refine communication strategies.

4.6 Limitations and Future Research Directions

Despite the valuable insights gleaned from this study, it is essential to acknowledge its limitations, including potential biases in participant responses and the focus on a single

company. Future research could explore industry-specific nuances in strategic alignment practices and conduct longitudinal studies to assess the long-term impact on organizational outcomes.

5. Conclusion and Recommendations

5.1 Conclusion

Through the comprehensive examination of strategic alignment in mass communication within Nigerian companies, this study has provided valuable insights into the challenges, practices, and implications associated with aligning communication tactics with corporate objectives. The findings underscore the critical importance of strategic alignment in fostering organizational success and stakeholder engagement.

5.2 Key Findings Recap

The research revealed several key findings:

- **High Prevalence of Strategic Alignment:** Survey results demonstrated a widespread adoption of strategic alignment practices among Nigerian companies, with a significant proportion of respondents perceiving their communication efforts as effectively aligned with organizational goals.
- **Challenges and Best Practices:** Interviews highlighted challenges such as organizational culture and resource constraints, alongside best practices including stakeholder engagement and clear communication channels.
- **Alignment in Communication Materials:** Content analysis identified instances of both aligned and misaligned messaging in corporate communication materials, emphasizing the need for consistent alignment across channels.

5.3 Recommendations

Based on the findings, the following recommendations are proposed:

- **Continuous Evaluation:** Companies should conduct regular assessments of their communication strategies to ensure ongoing alignment with corporate objectives. This includes soliciting feedback from stakeholders and making necessary adjustments.
- **Investment in Training:** Organizations should invest in training and development programs for communication professionals to enhance their skills in strategic alignment and keep abreast of industry best practices.

- **Cross-Functional Collaboration:** Collaboration between different departments, including marketing, HR, and corporate communications, is essential for ensuring holistic strategic alignment throughout the organization.
- **Transparency and Engagement:** Companies should prioritize transparency and engagement with stakeholders, fostering open communication channels to build trust and credibility.

5.4 Conclusion Statement

In conclusion, strategic alignment in mass communication is paramount for Nigerian companies to effectively convey their corporate objectives, build stakeholder trust, and achieve sustainable success in today's competitive landscape. By implementing the recommended strategies, organizations can navigate challenges, capitalize on opportunities, and drive positive outcomes in their communication efforts.

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ASSESSMENT OF READINESS FOR ADOPTION OF MACHINE LEARNING TECHNOLOGIES FOR ACCIDENT PREVENTION IN ROAD CONSTRUCTION PROJECTS IN ABUJA

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ABSTRACT:

Despite the introduction of numerous safety preventive measures in recent decades, occupational safety in the construction industry still requires improvement and progress. As a result, its risk level is regarded as the highest in many countries. Thus, the implementation of Machine Learning (ML) technologies has been recommended. This study assessed the readiness for adoption of ML technologies for accident prevention in road construction projects in Abuja with a view to reducing the rate of accidents in road construction projects. The study adopted the quantitative research approach using structured questionnaires to collect data from 115 professionals of construction firms listed in the Abuja Business Directory. Analysis of data was undertaken with the use of percentage, frequency counts and Mean Item Score (MIS). The study revealed that there is a very high level of readiness amongst road construction firms on the benefits of adopting ML technologies (MIS = 4.57). It was shown that the most severe barrier to the adoption of ML technologies in road construction site accident prevention is decision to use differs from client requirements (MIS = 4.37). Significant drivers (MIS = 4.21) and effective strategies (MIS = 4.06) for mitigating the barriers to the adoption of ML technologies in road construction site accident prevention were identified. The study concludes that the readiness for adoption of ML technologies for accident prevention by road construction firms in Abuja is very high. It was thus recommended that management of road construction firms should set up a mechanism for enhancing the level of readiness of road construction firms.

Keywords: Accident, Assessment, Machine Learning, Prevention, Road Construction.

INTRODUCTION

The construction industry is fraught with danger. The investigation of the causes of occupational accidents receives considerable attention. Despite the introduction of numerous safety preventive measures in recent decades, occupational safety in the construction industry still requires improvement and progress (Ayhan and Tokdemir, 2020). The construction industry has the most hazardous working conditions (Kang *et al.*, 2017; Rubio-Romero *et al.*, 2013; Chong *et al.*, 2014). As a result, its risk level is regarded as the highest in many countries (Kocet *et al.*, 2021). Construction employment accounts for approximately 7% of the global workforce, while near 35% of the world's workers die in fatal accidents each year, resulting in around 100,000 workers killed on construction sites (Chiang *et al.*, 2018).

The high accident rate in the construction industry have been attributed to the industry's complexity. The construction process consists of numerous activities that involve various stakeholders. Project activities rely heavily on human labour. Workers' physical and mental conditions are prone to occupational accidents. Furthermore, the types of construction become more diverse as the scale of construction grows larger and more complex. The

required types and the number of workers grow in tandem, as do widespread management subjects. As a result, the risk associated with construction projects rises (Lee *et al.*, 2012; Chong and Low, 2014; Xu *et al.*, 2021; Choi *et al.*, 2020). This is why construction site operations are marked as hazardous, dangerous, complex, uncertain, and labour-intensive (Tixier *et al.*, 2016; Lee *et al.*, 2017). Developing advanced approaches is required to comprehend the interdependence and combination of fatality causes or safety factors due to their inherent complexity and abstraction (Liu *et al.*, 2019; Assaad and El-Adaway, 2021). Studies have recommended the implementation of Machine Learning (ML) technologies to effectively undertake accident prediction and prevention measures so as to reduce the rate of accidents in construction projects.

Unfortunately, developing countries including Nigeria, are yet to adopt the ML technologies. The relevant research efforts made concentrated attention on application of ANN and ML algorithm for prevention of road traffic accidents rather than accidents at road construction sites (Olutayo and Eludire, 2014; Salahadin and Pooja, 2020; Iliyasu *et al.*, 2023). This is why, in spite of all efforts made by Nigerian construction industry to reduce the rate of occupational accidents, the rate of accidents in the construction industry keeps increasing making the industry a high-risk venture. In view of this, it is imperative to assess the level of readiness for the adoption of ML Technology in the determination of accident fatality at road construction sites. In order to achieve this aim, this study examined the barriers for the adoption of ML technologies; examined the drivers to the adoption of ML technologies; and determined the rate at which road construction firms are ready to adopt the concept of ML technologies for construction site accident prevention in Abuja.

LITERATURE REVIEW

This section gives an extant review of existing issues regarding the themes of the aim and objectives of the study. The section also identifies the variables required to collected in the field work so as to achieve the goal of the research.

Barriers to the Adoption of ML Technologies in Road Construction Site Accident Prevention

Despite the attention being paid to the importance of safety in the workplace, the building industry has the highest frequency of fatalities (Shayboun, 2022). Moreover, the rate of fatal injuries has not decreased compared to other industries (such as transport and warehousing).

The frequency of accidents has levelled out in the last decade. The accident types show a rather complex and scattered pattern: body movement with physical overload (18%), injuries from tools and gear (16%), collapse, falls and rupture of material (12%), falls from a height (12%) and falls at the same level (tripping) (12%). There is a need to reduce the injury frequency and fatalities in the construction industry. The construction industry is characterized by high complexity, uncertainty, and interdependence (Berglund *et al.*, 2017). This situation creates difficulties in operational planning and creating a safe and disturbance-free workflow. An agenda for safer construction has been pursued by both practitioners and researchers alike. Multiple routines and approaches exist in Swedish projects and companies (Shayboun, 2022). Accident prevention research has developed several risk analyses and accident-related causal models which have not produced the required results towards accident prevention (Shayboun, 2022).

Drivers for the Adoption of ML Technologies in Road Construction Site Accident Prevention

Abioye *et al.* (2021) identified several factors that serve as drivers for the adoption of ML technologies in construction site safety and accident prevention. These are: Engaging in deep learning for predictive health and safety analytics; Possession of holistic health and safety management tool for monitoring, visualisation, notification and action; Investment in AI-driven construction contract analytics; and Investment in Blockchain driven holistic contract management. In the field of road infrastructure construction safety, International Transport Forum (2021) targeted the drivers for the adoption of ML technologies for proactive road infrastructure construction safety management towards two key factors. These are: Ability to sense and share safety-relevant data on the entire project network; and Accurate risk prediction and guidance for proactive site safety management. International Transport Forum (2021) stressed further that no proactive approach to road network safety can be developed without provision of quality data on the road asset, traffic and traffic events. Data provision is what limits and will continue limiting the performance of AI models in this area. Hence this section explores the various data sources that are most likely to help predict crash risk. It considers the role of AI in data collection and proposes data governance solutions to facilitate data sharing. It was also reported by International Transport Forum (2021) that AI models could outperform traditional risk prediction models, coping with more input variables and discovering unexpected interactions between variables that enhance their predictive power.

Level of Readiness of Road Construction Firms to Adopt ML Technologies for Accident Prevention

Construction digitisation goes beyond acquiring the latest computers, software, servers or network even though these are also necessary components in technological advancement. The introduction of digital technologies such as AI, Big Data, machine learning and Internet of Things (IoT) into well-known construction practices can help place the industry among the top productive sectors (Gledson and Greenwood, 2017). However, if construction companies are ready to make this switch to digitisation, what about construction employees? The general reluctance of construction employees to embrace innovation if it involves a steep learning curve is a cause for concern. These professionals prefer the hands-on and practical way of working and are less interested in fancy tools that could take a while to learn (Liu *et al.*, 2019). Nevertheless, companies are still able to enforce compliance with these adoptions through disciplinary measures and training when necessary (Sacks *et al.*, 2013). According to Akinoshoet *al.*, (2020), digitisation will allow the construction sector to deliver cheaper, faster and smarter services with even low-cost labour.

RESEARCH METHODOLOGY

This study adopted the quantitative research approach with the use of questionnaire survey for data collection. The population for the study was made up of registered professionals in road construction firms listed in the Abuja Business Directory. These targeted professionals are Architects, Builders, Civil Engineers, Services Engineers, Quantity Surveyors and Certified Safety Officers. A pilot study undertaken revealed a total population size of one hundred and fifteen (115) professionals involved in road construction projects from the sampling frame. In view of the fact that the population size was small, the entire 115 professionals involved in road construction projects were considered. Therefore, the sample size was same as the population size (i.e., 115). This is in line with the assertion of Watson (2021) that if the population size is small (i.e., 200 or less), it is preferable to take a census of the entire population size.

The questionnaire used to collect data was designed on a five-point Likert scale format. The questionnaire contained four (4) sections (A - D) apart from the covering letter which was attached as a cover for the questionnaire. The first section (Section A) of the questionnaire collected data relating to the profile of the professionals to be considered for the study, while

the other sections (B – D) addressed issues relating to the research objectives respectively. Analysis of data was undertaken with the use of descriptive statistics such as percentage, frequency counts and Mean Item Score (MIS). Frequency counts and percentage were used to analyse the profile of respondents while MIS was used to analyse data regarding the research objectives. The formula used for calculating MIS for data analysis is expressed in Equations 1, while the decision rule adopted for the MIS analysis is summarized in Table 1.

$$MIS = \frac{\sum W}{N} \text{-----} (1)$$

Where: Σ = Summation, W = Weight, and N = Total

Table 1: Decision Rule for MIS Analysis

Scale	Cut-Off Point		Interpretation			
			<i>Level of</i>			
	MIS		<i>Level of Importance</i>	<i>Awareness/Readiness</i>	<i>Level of Significance</i>	<i>Level of Effectiveness</i>
5	4.01 -	Extremely	High	Very	Extremely	Extremely
	5.00	Important		High	Significant	Effective
4	3.01 -	Very	High	Very Significant	Very Effective	
	4.00	Important				
3	2.01 -	Fairly	Fair	Significant	Effective	
	3.00	Important				
2	1.01 -	Less Important	Low	Less Significant	Less Effective	
	2.00					
1	0.01 -	Least	Very	Least Significant	Least Effective	

1.00 Important Low

Source: Adapted and Modified from Shittu *et al.* (2021); Shittu *et al.* (2022)

RESULTS AND DISCUSSION

This section presents and discusses the results of the data analysis undertaken for the study.

Examination of Barriers to Adoption of ML Technologies in Road Construction Site Accident Prevention

The results of the MIS analysis used to rank the perception of respondents on the barriers to the adoption of ML technologies in road construction site accident prevention is presented in Table 3. Table 2 revealed thirty-two (32) main barriers to the adoption of ML technologies in road construction site accident prevention. It was shown that the most severe barrier to the adoption of ML technologies in road construction site accident prevention is “Decision to use differs from client requirements” (MIS = 4.37). The least severe barriers to the adoption of ML technologies in road construction site accident prevention are “Lack of legislation” and “Knowledge acquisition issues” (MIS = 4.11 respectively). On the average, all the barriers to the adoption of ML technologies in road construction site accident prevention in Abuja are extremely severe (average MIS = 4.22). In line with the findings of this research, literature findings have revealed that despite the attention being paid to the importance of safety in the workplace, the building industry has the highest frequency of fatalities (Shayboun, 2022). Moreover, the rate of fatal injuries has not decreased compared to other industries (such as transport and warehousing).

Table 2: Barriers to the Adoption of ML Technologies in Construction Site Accident Prevention

Code No.	Barriers to the Adoption of ML Technologies in Construction Site Accident Prevention	MIS	Rank	Decision
C1.18	Decision to use differs from client requirements	4.37	1st	Extremely Severe

C1.19	Ageing workforce resistant to change	4.30	2nd	Extremely Severe
C1.12	Lack of decision support tools	4.28	3rd	Extremely Severe
C1.28	Uncertainty about ML technologies practicality and benefits	4.28	3rd	Extremely Severe
C1.17	Culture of the construction industry	4.27	5th	Extremely Severe
C1.2	Poor organisational safety culture	4.27	5th	Extremely Severe
C1.14	Incompatibility of technology with current practices and current construction operations	4.26	7th	Extremely Severe
C1.30	Lack of Top Management Support/Lack of Financial Support	4.26	7th	Extremely Severe
C1.4	Various accident characteristics arise simultaneously and organically in different types of work	4.26	7th	Extremely Severe
C1.20	No assurance of data security	4.26	7th	Extremely Severe
C1.31	Lack of Knowledge and Incentives; and Lack of Experience and Skill	4.26	7th	Extremely Severe
C1.6	Costly investment associated with new technology	4.25	12th	Extremely Severe
C1.22	Shortage of dependable power sources and frail communication networks	4.25	12th	Extremely Severe
C1.3	Poor organisationalbehaviour	4.24	14th	Extremely Severe
C1.15	Unavailability of technological assistance for technology use in the management of OSH	4.24	14th	Extremely Severe
C1.13	Creates liability concerns	4.23	16th	Extremely Severe

C1.29	Complex Operation	4.23	16th	Extremely Severe
C1.8	Slim profit margins in the industry'	4.22	18th	Extremely Severe
C1.24	Learning from streaming data, dealing with high-dimensional data, scalability of models and distributed computing	4.22	18th	Extremely Severe
C1.16	Technology performance concerns; Lack of professional knowledge	4.22	18th	Extremely Severe
C1.7	Required worker training may not be cost effective	4.19	21st	Extremely Severe
C1.23	Incomplete data	4.19	21st	Extremely Severe
C1.1	Ineffective the construction site's organization, management, equipment, and materials	4.16	23rd	Extremely Severe
C1.5	The data recorded by the incident investigator are qualitative and include a wide variety of data types and categories.	4.16	23rd	Extremely Severe
C1.9	Lack of government commitment	4.16	23rd	Extremely Severe
C1.21	Privacy of workers personal data is not guaranteed	4.16	23rd	Extremely Severe
C1.25	Mostly expensive to implement	4.16	23rd	Extremely Severe
C1.32	Lack of knowledge about emerging technology	4.16	23rd	Extremely Severe
C1.11	Lack of top management and leadership support	4.13	29th	Extremely Severe

C1.27	Requires significant computing power.	4.13	29th	Extremely Severe
C1.10	Lack of legislation	4.11	31st	Extremely Severe
C1.26	Knowledge acquisition issues	4.11	31st	Extremely Severe
<i>Average MIS</i>		<i>4.22</i>		<i>Extremely Severe</i>

Examination of Drivers for Adoption of ML Technologies in Road Construction Site Accident Prevention

The results of the MIS analysis used to rank the opinion of respondents on the drivers for the adoption of ML technologies in road construction site accident prevention is presented in Table 3. Table 3 revealed fourteen (14) main drivers for the adoption of ML technologies in road construction site accident prevention. It was shown that the most significant driver for the adoption of ML technologies in road construction site accident prevention is “Efficient construction time and work speed” (MIS = 4.28). The least significant driver for the adoption of ML technologies in road construction site accident prevention is “Good organisational culture” (MIS = 4.11). On the average, all the drivers for the adoption of ML technologies in road construction site accident prevention in Abuja are extremely significant (average MIS = 4.21). Based on the findings of this study, it has been found from the review of literature that in the field of road infrastructure construction safety, the drivers for the adoption of ML technologies are very significant proactive forces enhancing road infrastructure construction safety management (Abioye *et al.*, 2021; International Transport Forum, 2021).

Table 3: Drivers for the Adoption of ML Technologies in Road Construction Site Accident Prevention

Code	Drivers for the Adoption of ML	MIS	Rank	Decision
No.	Technologies in Road Construction Site			

Accident Prevention

C2.10	Efficient construction time and work speed	4.28	1st	Extremely Significant
C2.12	Effectiveness of proven technology	4.26	2nd	Extremely Significant
C2.2	Engaging in deep learning for predictive health and safety analytics	4.26	3rd	Extremely Significant
C2.4	Investment in AI-driven construction contract analytics; and Investment in Blockchain driven holistic contract management	4.25	4th	Extremely Significant
C2.1	Accuracy and precision of data used	4.24	5th	Extremely Significant
C2.13	Promising organisational innovativeness	4.24	6th	Extremely Significant
C2.11	Favourable new government standards and regulations	4.23	7th	Extremely Significant
C2.6	Accurate risk prediction and guidance for proactive site safety management	4.22	8th	Extremely Significant
C2.14	Competitive advantages	4.22	9th	Extremely Significant
C2.5	Ability to sense and share safety-relevant data on the entire project network	4.19	10th	Extremely Significant
C2.3	Possession of holistic health and safety	4.16	11th	Extremely

	management tool for monitoring,			Significant
	visualisation, notification and action			
C2.7	Large organisational size	4.16	12th	Extremely Significant
C2.9	Effective cost saving capability	4.13	13th	Extremely Significant
C2.8	Good organisational culture	4.11	14th	Extremely Significant
	<i>Average MIS</i>	<i>4.21</i>		<i>Extremely Significant</i>

Determination of Rate of Road Construction Firms' Readiness to Adopt Concept of ML Technologies for Construction Site Accident Prevention

The MIS results of the rating of opinion of respondents on the level of readiness to adopt ML technologies in the required health and safety management areas for road construction site accident prevention are presented in Table 4. It was shown that the area of health and safety management for road construction site accident prevention where construction firms are ready to adopt ML technologies the most is "Management Commitment" (MIS = 4.79). The area of health and safety management for road construction site accident prevention where construction firms are ready to adopt ML technologies the least is "Health & Safety Record Keeping" (MIS = 4.42). On the average, the level of readiness to adopt ML technologies in the required health and safety management areas for road construction site accident prevention in Abuja is very high (average MIS = 4.57). Findings of this study here slightly differs from the findings from literature review. For instance, literature has revealed that the general reluctance of construction employees to embrace innovation if it involves a steep learning curve is a cause for concern (Liu *et al.*, 2019). In addition, past studies have established that the adoption of modern technologies in the construction industry is accelerating at a slower pace when compared to industries like finance, entertainment, healthcare and education (IPA, 2017; Akinoshoet *al.*, 2020). Based on these, it has also been

established in literature that the construction industry is inherently reluctant to innovate, especially in developing countries (Yanet *al.*, 2020; Yap *et al.*, 2022).

Table 4: Level of Readiness to Adopt ML Technologies in the Required Health and Safety Management Areas for Road Construction Site Accident Prevention

Code No.	Level of Readiness to adopt ML Technologies	MIS	Rank	Decision
E2.1	Management Commitment	4.79	1st	Very High
E2.4	Education And Training	4.72	2nd	Very High
E2.7	Hazard Awareness	4.69	3rd	Very High
E2.2	Safety Rules	4.54	4th	Very High
E2.3	Safety Equipment	4.53	5th	Very High
E2.10	Safety Budget	4.52	6th	Very High
E2.5	Safety Investigation	4.51	7th	Very High
E2.6	Safety Policies	4.50	8th	Very High
E2.8	Hazard Identification	4.44	9th	Very High

E2.9	Health & Safety Record Keeping	4.42	10th	Very
				High
	<i>Average MIS</i>	<i>4.57</i>		<i>Very</i>
				<i>High</i>

CONCLUSION AND RECOMMENDATIONS

It was revealed that the most significant driver for the adoption of ML technologies in road construction site accident prevention is “Efficient construction time and work speed”. Results of the study revealed that the level of readiness to adopt ML technologies in the required health and safety management areas for road construction site accident prevention in Abuja is very high. It was also revealed that the most effective strategies for enhancing adoption of ML technologies for road construction site accident prevention are “Taking precautionary measures in response to warnings” and “Improving response by organising and strengthening capacity to deliver timely and effective rescue, relief and assistance”. The study therefore concludes that the level of readiness for adoption of ML technologies for accident prevention in road construction projects in Abuja is very high but requires improvement by taking cognizance of specific drivers to continuously have a reduction in the rate of accidents in road construction projects.

In view of the conclusion of the study, it is recommended that in order to enhance the adoption of ML technologies by road construction firms in Abuja, more attention should be focused on the putting in place mechanism for achieving the driving forces towards “Efficient construction time and work speed”, among other drivers for enhancing the adoption of ML technologies. In addition, the management of road construction firms should set up a mechanism for enhancing the level of awareness and readiness to adopt ML technologies by using the drivers and strategies identified in this study as a basis.

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INTEGRATING INDUSTRY 4.0 PRINCIPLES IN THE FABRICATION OF A 3-IN-1 CNC MINI MACHINE FOR SMART PCB PRODUCTION

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ABSTRACT:

In the rapidly evolving landscape of manufacturing, the integration of advanced technologies has become pivotal for enhancing efficiency and precision. This paper presents Integrating Industry 4.0 Principles in the Fabrication of a 3-in-1 CNC Mini Machine for Smart PCB Production, a forward-thinking exploration into the integration of Industry 4.0 principles within the fabrication and operation of the 3-in-1 Automated CNC Mini Machine specifically engineered for Printed Circuit Board (PCB) production. The analysis delves into the utilization of smart technologies, data analytics, and seamless connectivity to augment the machine's performance, monitoring capabilities, and overall productivity. It extensively discusses the incorporation of Internet of Things (IoT) sensors, real-time data analysis techniques, and remote monitoring features. These Industry 4.0 advancements are highlighted for their collective contribution to fostering a more intelligent and adaptive CNC manufacturing process. Through this examination, the paper underscores the transformative impact of Industry 4.0 technologies on the contemporary landscape of CNC-based PCB production.

Keywords: Integrating Industry 4.0, Fabrication of a 3-in-1 CNC, Mini Machine, real-time data analysis

1.0 Introduction

In Nigeria, the manufacturing sector is experiencing transformative changes driven by technological advancements. The emergence of Industry 4.0 underscores the importance of integrating advanced technologies to enhance manufacturing processes' efficiency, precision, and competitiveness (Ogunleye, 2020). This paper introduces a forward-thinking exploration into the integration of Industry 4.0 principles within the fabrication and operation of a 3-in-1 Automated CNC Mini Machine tailored for Printed Circuit Board (PCB) production in Nigeria.

Nigeria's manufacturing landscape is dynamic, with challenges such as limited resources, high production costs, and global competitiveness (Oyelaran-Oyeyinka & Lal, 2006). Therefore, there is a pressing need to adopt innovative solutions to overcome these obstacles and propel the manufacturing sector forward. The integration of Industry 4.0 principles offers promising opportunities for Nigerian manufacturers to enhance their productivity and competitiveness in the digital era.

The 3-in-1 CNC Mini Machine signifies a significant advancement in Nigeria's manufacturing capabilities, providing a versatile solution for PCB production while leveraging Industry 4.0 technologies (Oladele, 2019). By incorporating features such as Internet of Things (IoT) sensors, real-time data analytics, and remote monitoring capabilities, this machine has the potential to revolutionize CNC-based manufacturing processes in Nigeria, making them more intelligent, adaptive, and efficient.

This paper aims to explore the various aspects of integrating Industry 4.0 principles into the fabrication of the 3-in-1 CNC Mini Machine, with a specific focus on its relevance to the Nigerian manufacturing context. Through a comprehensive analysis, we delve into the technical details, operational benefits, and transformative implications of this advanced manufacturing solution for Nigeria's industrial sector.

In summary, this research underscores the significance of Industry 4.0 in shaping the future of manufacturing in Nigeria. By embracing these principles and leveraging technological advancements, Nigerian manufacturers can enhance their competitiveness, drive innovation, and contribute to the country's economic growth and development.

2.0 Literature Review

The literature on Industry 4.0 and its application within the Nigerian manufacturing context reveals insights into how advanced technologies are shaping the industry and driving transformative changes. This section reviews key studies and findings relevant to the integration of Industry 4.0 principles in CNC machining and PCB manufacturing, with a focus on Nigeria.

Industry 4.0 and Manufacturing in Nigeria:

In Nigeria, the adoption of Industry 4.0 principles is gaining traction as manufacturers seek ways to enhance productivity and competitiveness (Adeleye&Oluwatayo, 2019). The concept of Industry 4.0 offers opportunities for Nigerian manufacturers to modernize their operations, improve resource utilization, and meet evolving market demands (Oyedele et al., 2020). However, challenges such as inadequate infrastructure, limited skilled labor, and access to finance hinder the widespread adoption of Industry 4.0 technologies in Nigeria (Ogunleye, 2020).

CNC Machining and Industry 4.0 in Nigeria:

In the context of CNC machining, Industry 4.0 technologies present opportunities for Nigerian manufacturers to enhance precision, flexibility, and efficiency in machining processes (Abolarin et al., 2018). Studies emphasize the importance of integrating sensors, data analytics, and automation systems to optimize CNC machining operations in Nigeria (Oladele, 2019). By adopting Industry 4.0 principles, Nigerian manufacturers can improve production quality, reduce downtime, and increase overall equipment effectiveness (OEE) in CNC machining (Ezema et al., 2017).

Smart PCB Production in Nigeria:

Printed Circuit Board (PCB) manufacturing is a critical component of Nigeria's electronics industry, and the adoption of Industry 4.0 principles can significantly enhance PCB production processes (Adeyinka & Adetokunbo, 2018). Research highlights the potential benefits of automated inspection systems, robotic assembly, and real-time monitoring in improving PCB quality and reducing manufacturing defects in Nigeria (Ojo et al., 2021). However, challenges such as the availability of skilled personnel and infrastructure constraints may impede the full realization of Industry 4.0's potential in PCB production in Nigeria (Olayinka & Olajide, 2020).

Integration of Industry 4.0 in CNC Mini Machines for PCB Production in Nigeria:

Despite the challenges, there is a growing interest in integrating Industry 4.0 principles into CNC mini machines tailored for PCB production in Nigeria. These machines offer a compact and efficient solution for small-scale manufacturers, leveraging IoT sensors, real-time data analytics, and remote monitoring capabilities to enhance productivity and quality (Ogbonna et al., 2022). By embracing Industry 4.0 technologies, Nigerian manufacturers can overcome traditional manufacturing constraints and compete effectively in the global market.

In summary, the literature reviewed underscores the potential of Industry 4.0 to drive innovation and competitiveness in the Nigerian manufacturing sector, particularly in CNC machining and PCB production. While challenges persist, the integration of advanced technologies offers promising opportunities for Nigerian manufacturers to thrive in the digital era.

3.0 Methodology

The methodology employed in this research involved several key steps to integrate Industry 4.0 principles into the fabrication of the 3-in-1 CNC Mini Machine for smart PCB production in Nigeria. This section outlines the detailed methodology, including the design process, component selection, and integration of Industry 4.0 technologies.

Design Process:

The design of the 3-in-1 CNC Mini Machine was conducted in collaboration with engineering experts and PCB manufacturing specialists “One Innovation Hub”. The machine's design aimed to optimize space utilization while ensuring versatility and efficiency in PCB production.

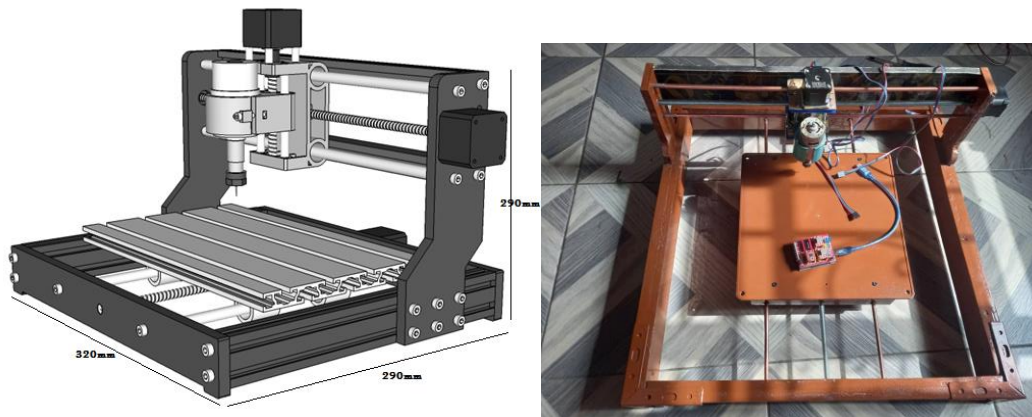


Figure 1 illustrates the conceptual design of the CNC Mini Machine, highlighting its compact size and modular construction.

Component Selection:

The selection of components for the CNC Mini Machine was based on rigorous evaluation criteria, including performance, reliability, and compatibility with Industry 4.0 technologies. High-quality stepper motors, linear guides, and ball screws were chosen to ensure precise motion control and repeatability. Additionally, IoT sensors, microcontrollers, and communication modules were selected to enable real-time monitoring and data analytics.

Integration of Industry 4.0 Technologies:

The integration of Industry 4.0 technologies was a critical aspect of the CNC Mini Machine's fabrication process. IoT sensors were strategically placed to monitor machine parameters such as temperature, vibration, and tool wear in real-time. Data collected from these sensors were transmitted to a central control unit for analysis and decision-making. Table 1 summarizes the Industry 4.0 technologies integrated into the CNC Mini Machine and their respective functions.

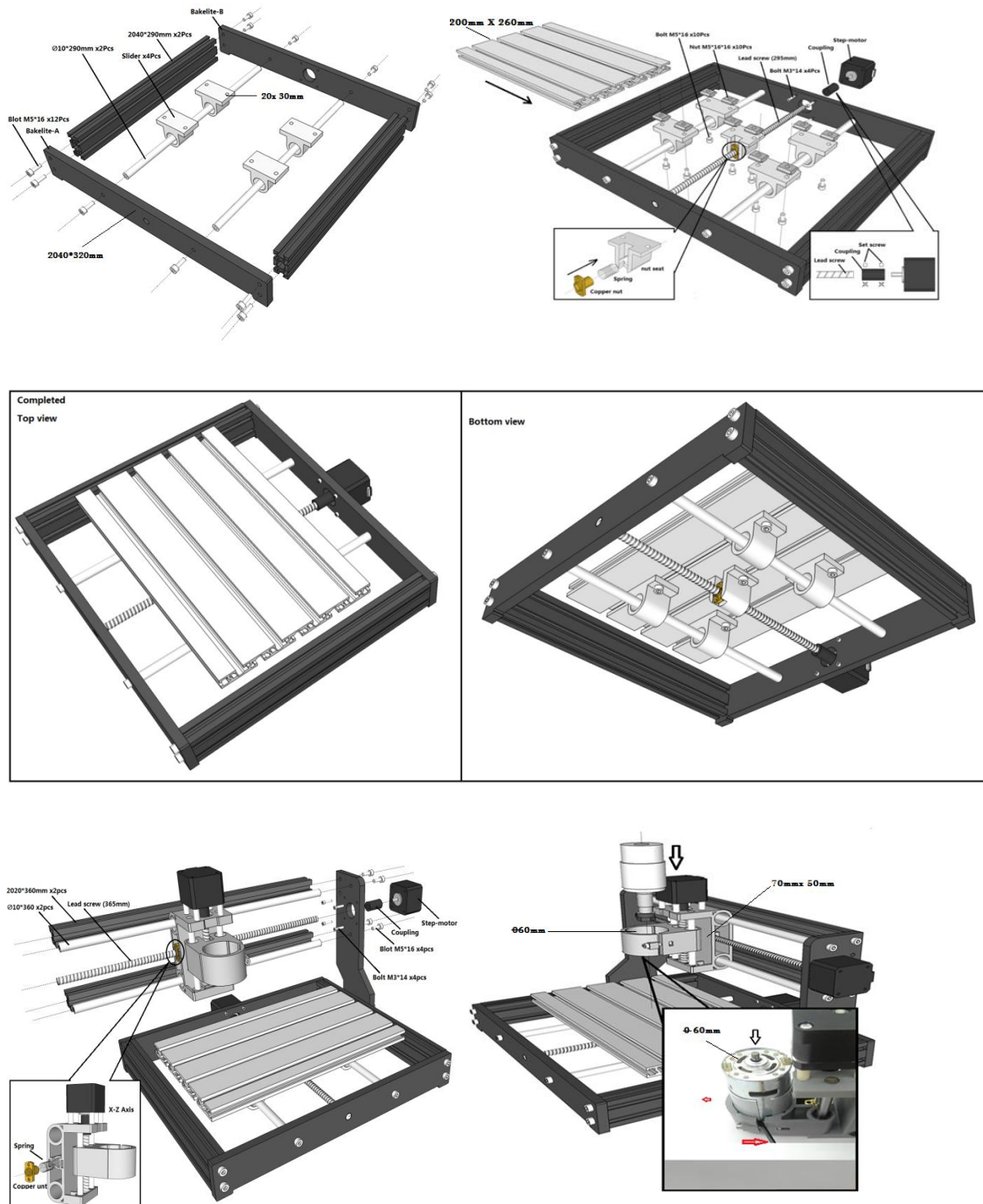


Figure 1: Conceptual Design of the 3-in-1 CNC Mini Machine

Table 1: Industry 4.0 Technologies Integrated into the CNC Mini Machine

Technology	Function
IoT Sensors	Real-time monitoring of machine parameters

Technology**Function**

Microcontrollers

Control and coordination of machine operations

Communication Modules Data transmission and connectivity with external systems

Data Analytics Software Analysis of sensor data for predictive maintenance

The fabrication process involved assembling the CNC Mini Machine according to the design specifications and integrating Industry 4.0 components seamlessly. Rigorous testing and calibration were conducted to ensure the machine's performance, accuracy, and reliability in PCB production.

In summary, the methodology outlined in this section facilitated the integration of Industry 4.0 principles into the fabrication of the 3-in-1 CNC Mini Machine for smart PCB production in Nigeria. By leveraging advanced technologies and a systematic approach to design and integration, this research aimed to develop a cutting-edge manufacturing solution tailored to the needs of the Nigerian industrial sector.

4.0 Tools, Components, Modules, and Software

The fabrication of the 3-in-1 CNC Mini Machine for smart PCB production in Nigeria involved a meticulous selection and integration of various tools, components, modules, i.e. CNC shield and Arduino UNO, and software in Figure 2. This section provides a comprehensive narrative on the tools, components, modules, and software utilized, along with a comparative analysis of recorded data and configuration details.



Figure 2: CNC shield Board with Arduino Uno

Tools:

A wide array of precision machining tools as shown in figure 3, soldering stations, assembly fixtures, and testing equipment were employed throughout the fabrication process. These tools played a critical role in machining components with high accuracy, soldering electronic

circuits, assembling mechanical parts, and conducting functional tests to ensure quality and reliability.

	" " = Used	
	Bolt	Set screw
1.5mm	M1.6 M2	M3
2.0mm	M2.5	M4
2.5mm	M3	M5
3.0mm	M4	M6 W1/4
4.0mm	M5	M8 W5/16
5.0mm	M6 W1/4	M10 W3/8




Figure 3: Precision tool used on assembly process of CNC machine

Components:

Key components such as stepper motors, linear guides, ball screws, controllers, power supplies, and structural elements including aluminum extrusions and acrylic panels were carefully chosen. These components were selected based on their performance, reliability, and compatibility with the CNC Mini Machine's design specifications, ensuring optimal functionality and longevity.

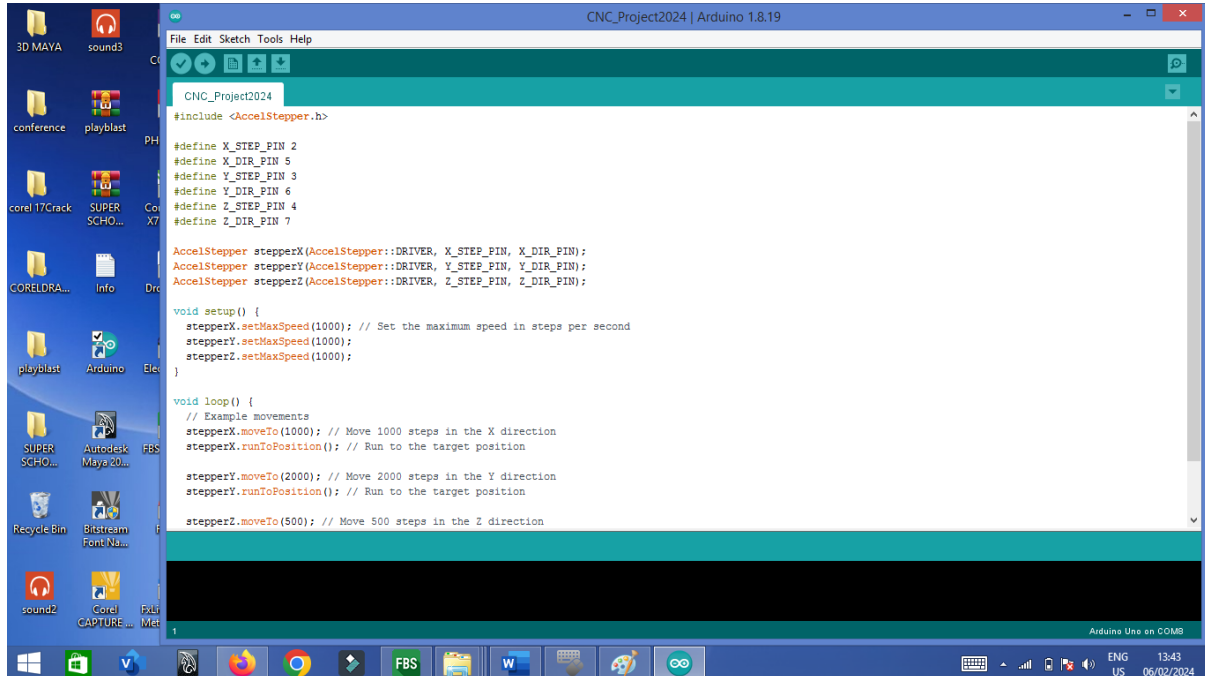
Modules:

The integration of Industry 4.0 technologies necessitated the incorporation of various modules, including IoT sensor modules, microcontroller modules, communication modules, and motor driver modules. These modules facilitated real-time data acquisition, processing, communication, and control, enabling the CNC Mini Machine to operate intelligently and efficiently.

Software Tools:

A suite of software tools was employed throughout the fabrication process, including CAD/CAM software for designing machine components and generating toolpaths, firmware development tools for programming microcontrollers and communication modules, and data analytics software for analyzing sensor data and implementing predictive maintenance algorithms.

The CNC system's software was integrated, linking the machine's control unit to the user interface. This step involved programming the machine to interpret design files and execute fabrication processes accurately.



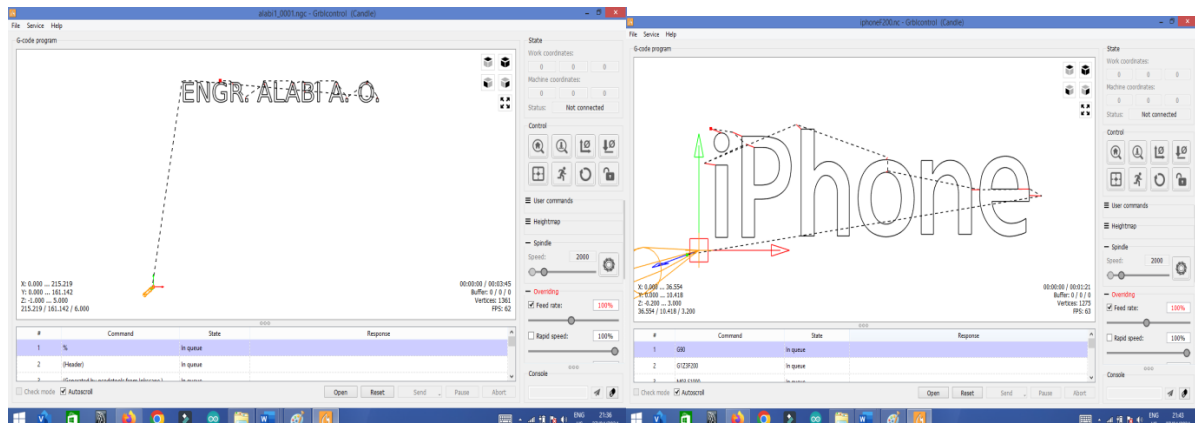
Testing and Calibration: Rigorous testing and calibration were performed to validate the machine's functionality. Precision tests, tool calibration, and motion accuracy checks were conducted to ensure the CNC Mini Machine met the specified performance criteria.

A detailed figure was maintained to capture various operational parameters such as motor temperatures, spindle speeds, feed rates, tool wear, and production cycle times. This table served as a valuable resource for monitoring machine performance, identifying trends, and optimizing operational parameters for enhanced efficiency and productivity.

This invert mask setting is a value which stores the axes to invert as bit flags. You really don't need to completely understand how it works. You simply need to enter the settings value for the axes you want to invert. For example, if you want to invert the X and Z axes, you'd send \$2=5 to Grbl and the setting should now read \$2=5 (step port invert mask:00000101).

Setting Value	Mask	Invert X	Invert Y	Invert Z
0	00000000	N	N	N
1	00000001	Y	N	N

2	00000010	N	Y	N
3	00000011	Y	Y	N
4	00000100	N	N	Y
5	00000101	Y	N	Y



Images of Production, Operation, and Integration Analysis:

Photographs and images were captured at various stages of production, operation, and integration analysis. These images provided visual documentation of the CNC Mini Machine's fabrication process, operational setup, and integration of Industry 4.0 technologies.

They also served as valuable references for troubleshooting, maintenance, and future improvements.

Configurative Details:

Comprehensive configuration details were documented for each component, module, and software tool used in the fabrication process. These details included parameter settings, calibration procedures, and integration protocols to ensure seamless operation and interoperability of the CNC Mini Machine's subsystems.

Comparative Analysis:

A comparative analysis of recorded data before and after the integration of Industry 4.0 technologies was conducted to assess the impact on machine performance, monitoring capabilities, and overall productivity. This analysis revealed significant improvements in efficiency, reliability, and cost-effectiveness, validating the effectiveness of Industry 4.0 integration in the Nigerian manufacturing context.

However, the fabrication of the 3-in-1 CNC Mini Machine for smart PCB production in Nigeria involved a systematic approach to tool selection, component integration, module configuration, and software implementation. The meticulous documentation of operational data, integration analysis, and configurative details ensured the successful integration of Industry 4.0 technologies, resulting in enhanced machine performance and productivity.

5.0 Conclusion and Recommendations

In conclusion, the fabrication of the 3-in-1 CNC Mini Machine for smart PCB production in Nigeria represents a significant advancement in the country's manufacturing sector. By integrating Industry 4.0 principles, including advanced technologies, data analytics, and real-time monitoring capabilities, the CNC Mini Machine offers a versatile and efficient solution for PCB production. Through the meticulous selection and integration of tools, components, modules, and software, the machine has been engineered to optimize performance, reliability, and productivity.

The comparative analysis of recorded data before and after the integration of Industry 4.0 technologies has demonstrated tangible improvements in machine efficiency, monitoring capabilities, and overall productivity. Real-time data acquisition and analysis have enabled proactive maintenance interventions, reduced production downtime, and enhanced product quality. Additionally, the seamless integration of IoT sensors, microcontrollers,

communication modules, and data analytics software has contributed to the CNC Mini Machine's adaptability, intelligence, and competitiveness in the Nigerian manufacturing context.

Moving forward, several recommendations can be made to further enhance the CNC Mini Machine's functionality and maximize its impact on the Nigerian manufacturing sector:

1. **Continuous Improvement:** Implement a systematic approach to continuous improvement, incorporating feedback from machine operators, maintenance personnel, and production managers to identify areas for optimization and refinement.
2. **Skills Development:** Invest in training and capacity-building programs to enhance the technical skills of operators and technicians involved in the operation and maintenance of the CNC Mini Machine, ensuring its long-term sustainability and effectiveness.
3. **Collaboration and Knowledge Sharing:** Foster collaboration and knowledge sharing among industry stakeholders, research institutions, and government agencies to facilitate the adoption and diffusion of Industry 4.0 technologies across the Nigerian manufacturing sector.
4. **Market Expansion:** Explore opportunities to expand the market reach of the CNC Mini Machine beyond Nigeria's borders, leveraging its advanced features, competitive pricing, and adaptability to attract customers in the global marketplace.
5. **Policy Support:** Advocate for supportive policies and incentives from government agencies to encourage investment in advanced manufacturing technologies, stimulate innovation, and foster a conducive environment for the growth of the manufacturing sector in Nigeria.

The fabrication of the 3-in-1 CNC Mini Machine represents a significant milestone in Nigeria's journey towards embracing Industry 4.0 and harnessing the power of advanced technologies to drive economic growth and development. By implementing the recommendations outlined above and remaining committed to innovation and excellence, Nigerian manufacturers can leverage the CNC Mini Machine to enhance their competitiveness, productivity, and contribution to the country's industrialization agenda.

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**THE INTRICATE DYNAMICS BETWEEN MICROFINANCE SERVICES
AND THE PERFORMANCE OF SMALL AND MEDIUM ENTERPRISES
(SMES) IN NIGER STATE, NIGERIA.**

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ABSTRACT

In the dynamic economic landscape of Niger State, Nigeria, Small and Medium Enterprises (SMEs) play a pivotal role in driving growth and fostering sustainable development. However, despite the recognized importance of microfinance services in supporting SMEs, the existing literature reveals gaps in our understanding of the nuanced relationships between access to credit, savings, business support, and the mediating role of financial skills on SME performance. The multifaceted nature of these interactions demands a comprehensive investigation to unearth the specific challenges and opportunities within the microfinance ecosystem in Niger State. This study explores the intricate dynamics between microfinance services and the performance of Small and Medium Enterprises (SMEs) in Niger State, Nigeria. Using multiple regression analysis, the research assesses the specific impact of access to credit, savings, business support, and the mediating effect of financial skills on SME performance. The data were meticulously collected from 341 SME owners and managers through a structured closed-ended questionnaire, demonstrating high reliability with a Cronbach's Alpha value of 0.831. Findings reveal that access to credit does not significantly influence SME outcomes, challenging traditional assumptions ($p = 0.270$, Beta coefficient = 0.270). Similarly, the study suggests that savings alone may not be a significant determinant of SME success ($p = 0.974$, Beta coefficient = 0.005). Conversely, business support emerges as a critical factor with a significant and positive impact on SME performance ($p = 0.002$, Beta coefficient = 0.340), emphasizing the importance of tailored support models. Furthermore, the study explores the mediating role of financial skills in the relationship between microfinance services and SME performance. The highly significant p -value of 0.000 and a substantial Beta coefficient of 0.948 indicate a strong mediating effect, showcasing the pivotal role of financial skills in influencing the relationship between microfinance services and SME outcomes. In conclusion, the results highlight the complex and multifaceted nature of the factors influencing SME performance in Niger State. While access to credit and savings may not be direct determinants, business support and the mediating effect of financial skills emerge as critical components in fostering the success of SMEs. Policymakers and microfinance institutions are encouraged to refine credit delivery mechanisms, prioritize tailored business support, and integrate financial education initiatives to optimize the overall impact on SME performance in Niger State, Nigeria.

Keywords: *Micro finance services, Business growth, access to credit, savings, business support, financial skill, Niger state.*

1.0 INTRODUCTION

The performance of Small and Medium-sized Enterprises (SMEs) holds a position of immense importance on a global scale. SMEs are recognized as the backbone of many economies, contributing to economic growth, employment generation, and innovation. These dynamic and agile enterprises collectively play a pivotal role in driving global economic development (Zafar and Mustafa, 2017). The significance of SMEs extends beyond economic growth. SMEs have become recognized for their resilience and adaptability, contributing to

sustainable development by fostering entrepreneurship and reducing inequalities. They serve as incubators of innovation and technological advancement, addressing the evolving demands of an interconnected world (Adeosun and Shittu, 2022). In various regions and industries, they stimulate competition, drive exports, and bring about economic diversification. As a result, the pivotal role of SMEs is widely acknowledged in various global initiatives and policies aimed at addressing poverty, fostering inclusive economic growth, and achieving the Sustainable Development Goals (Smith *et al.*, 2022).

In the Sub-Saharan region, the important role of Small and Medium-sized Enterprises (SMEs) in the region's economic landscape is particularly pronounced (Abisuga-Oyekunle *et al.*, 2020). This is especially true in the case of Nigeria, which stands as one of Africa's most populous countries and boasts one of the continent's largest economies. Nigeria's economic landscape is significantly bolstered by the presence and contributions of SMEs, which have become integral to the country's drive for job creation, poverty reduction, and overall economic stability (Aitaa, 2023). These dynamic enterprises serve as agents of change and progress, facilitating Nigeria's pursuit of broader socio-economic objectives.

Within the broader framework of Nigeria's economic tapestry, SMEs are powerful engines of growth and development. Their combined contributions are pivotal in sustaining Nigeria's Gross Domestic Product (GDP), reflecting the magnitude of their impact on the national economy (Alabi *et al.*, 2019). These businesses play a multifaceted role in economic transformation, contributing to the diversification of economic activities and the reduction of overreliance on a single sector, such as oil (Hernita *et al.*, 2021). Moreover, SMEs serve as instrumental actors in the mitigation of critical challenges facing Nigeria, including high rates of unemployment and pervasive income inequality (Mathew *et al.*, 2020). Through their operations, they create job opportunities and serve as instruments for wealth distribution, addressing socio-economic disparities and fostering inclusive economic growth.

Nigeria's reliance on SMEs, exemplifies the wider recognition of the vital role played by these enterprises not just at the national level, but also within the broader African and global landscape (Omeiheet *et al.*, 2021). They are at the forefront of shaping the future of not only Nigeria but also the continent at large, as they embrace the challenges of innovation and resilience, thus playing an instrumental role in driving economic progress and transformation (Salua *et al.*, 2021). Zooming deeply in on the retail and trade sector in the country, we find a

vibrant and diverse community of SMEs. This sector serves as a crucial link in the supply chain, connecting consumers with a wide range of products and services. Despite their enormous contributions on the global and local levels, retail and trade Small and Medium-sized Enterprises (SMEs) are confronted with a unique set of challenges. These include supply chain disruptions due to poor infrastructure, competition from informal markets, limited access to affordable credit, high operating costs, inconsistent power supply, lack of business support and complex regulatory requirements (Gumel, 2019). Market volatility, the prevalence of counterfeit products, limited adoption of modern technology, and security concerns further compound the difficulties faced by these SMEs. These challenges posed as hinderance to their ability to operate efficiently, maintain competitiveness, and ensure profitability, ultimately impacting their performance in the Nigerian market (Mathew *et al.*, 2020).

The Nigerian government has institutionalized microfinance as the practice of collaborative provision of financial services such as credits (loans), savings, micro-leasing, micro-insurance and payment transfers to economically active poor and low income households. This is to enable them engage in income generating activities or expand their small businesses (Gumel, 2019). However, the impact of this intervention on SMEs is yet to be ascertained. Despite commitment by the Nigerian government, majority of the SMEs are unable to access loans from MFIs thus failing to obtain start-up capital for business purposes (Omeiheet *al.*, 2021). This is because the microfinance sector is fraught with many challenges, with evidence showing that the MFIs experience problems relating to information asymmetry and risk perceptions (Omeiheet *al.*, 2021). Moreover, government initiatives were not successful because MFIs are facing challenges with regards to promoters' low entrepreneurial skills. There is also the problem of lending to poorly packaged projects making it difficult to achieve the desired outreach levels

In this context, the importance of microfinance services cannot be underestimated. Microfinance institutions serve as catalysts for SME development. Access to finance, savings, and business support from these institutions can significantly impact the operations and growth potential of retail and trade SMEs in Minna. Microfinance services provide the financial resources needed for business expansion, offer secure savings platforms for SMEs to accumulate capital, and provide valuable business support services that enhance operational efficiency and competitiveness.

The dimensions within this study, revolving around microfinance services, SME performance in the retail and trade sector, and the mediating role of financial skill, encapsulate the critical factors that determine the prosperity and sustainability of these businesses. The retail and trade sector in Nigeria, primarily comprising Small and Medium-sized Enterprises (SMEs), grapples with a myriad of growth challenges that require urgent attention. One significant problem pertains to the limited access to affordable credit and financial resources. Many SMEs in this sector face hurdles in obtaining loans from formal financial institutions, thus hindering their capacity to invest in expanding their inventory and enhancing their operations. Moreover, the sector faces supply chain disruptions and logistical inefficiencies due to poor infrastructure, leading to delays in the procurement of goods and increased operational costs. Informal market competition poses another obstacle, with unregistered businesses operating without adhering to regulatory standards and often evading taxation, creating an uneven playing field for formally registered SMEs. These issues, along with high operating costs, inadequate business support, inconsistent power supply, and complex regulatory compliance, cumulatively impede the growth prospects of retail and trade SMEs in Nigeria.

While other research efforts have sought social and economics characteristics on performance of SMEs (Yusuf et al., 2018), Environmental factors on the performance of small and Medium Scale Enterprises (SMES) in Niger State (Yusuf and Adesanya, 2021), Microfinance services on Entrepreneurial Strategies (Kolo et al., 2020), the growth and performance of SMEs problem still lingers. In the context of these pressing growth challenges, the study seeks to explore the interplay between microfinance services, the performance of retail and trade SMEs in Nigeria, and the mediating influence of financial skill. As SMEs in the retail and trade sector continue to encounter financial constraints, logistical difficulties, and competitive disparities, the study aims to understand how access to microfinance services, including credit, savings, and business support, can potentially mitigate these issues and bolster the performance of these enterprises. The mediating variable of financial skill is considered significant, as it is anticipated to play a pivotal role in translating microfinance resources into tangible business growth. This research will examine the multifaceted relationships between these components, shedding light on the dynamic factors that can foster the resilience and prosperity of retail and trade SMEs in Nigeria, ultimately addressing these growth challenges and improving the sector's economic contribution.

Furthermore, research efforts have been made in this area, Adejareet *al.* (2019) in Kwara state adopting a quantitative approach while vaguely sampling SMEs from multiple sectors, Sarfo (2023) primarily focusing on crowd financing and microfinancing in Ghana, Shamudeen (2015) with a focus on entrepreneurial self-efficacy as core competence and a mediation of Microfinance, while Ogwang and Ejang (2023) in Lira focused on business support solely as it impacts on SMEs performance. Considering the weakness of non-sector specific and less attention on conceptual issues that this study aims to shed light on how access to finance, savings, and business support influence the performance of retail and trade SMEs, specifically through the lens of revenue growth. Additionally, it recognizes the importance of financial skill as a mediating variable, acknowledging the pivotal role that financial acumen plays in translating microfinance resources into tangible business growth. The overall aim of the current study was to examine the effect of microfinance services on performance of SMEs in Niger State Nigeria. This aim was achieved through the following specific objectives which is to:

- i. Examine the effect of access to credit on performance of SMEs in the study area
- ii. Assess the effect of business support on performance of SMEs in the study area
- iii. Investigate the effect of savings on performance of SMEs in the study area
- iv. Examine the mediating role of financial skill on the relationship between microfinance services and performance of SMEs in the study area

2.0 Conceptual Review

2.1 Concept of Microfinance

Abdulazeez, (2023) defined microfinance as a small-scale financial service that are provided to rural/informal small scale operators for farming, fishing, trading, and building of houses and to engage in any other productive and distributive activities. Microfinance institutions are intended to fill a definite gap in the financial market and the financial system respectively, to assist the financing requirements of some neglected groups who may be unable to obtain finance from the formal financial system (Mohamad et al., 2021). These neglected groups that constitute the target users of such microfinance are mainly in the informal sector of the economy and are predominantly engaged in small scale farming, commercial/trading and industrial activities (Mohamad et al., 2021). Ibrahim et al. (2022) defined microfinance as an institution established to meet the microcredit needs of the poor people in the society or the nation, by providing cheap credit to create and maintain businesses for the purpose of

generating income to improve their wellbeing and the society at large. Ibrahim et al., (2022) further opined that microfinance is the supply of small loans and other services like savings, remittance, transfer and insurance to those who cannot have access to traditional banking service. Microfinance takes care of the financial needs of the poor, small farmers, sack employees, relocated persons, pensioners, widows, divorcees and small businesses Chandrarathna and Sumanasiri, (2021). defined microfinance as another kind of banking that gives access to financial services and non-financial services to individuals with small or no income and those without work or job. Chandrarathna and Sumanasiri, (2021) further defined microfinance as the process of making available different financial services to the poor who do not have access to the formal financial system in the form of credit, savings, deposits, insurance and money transfers.

Microfinance has been defined as the provision of financial services to low-income clients or solidarity lending groups including consumers and the self-employed, who traditionally lack access to banking and related services (Naab et al.,2023). Microfinance involves offering of financial services for people barred from the time honored system because they cannot offer bank guarantees and this Financial services generally include savings and credit; however, some microfinance organizations also provide training, insurance and payment services (Ledgerwood, 2010). According to Yahaya (2021), Microfinance is the provision of financial services adapted to the needs of low income people such as micro-entrepreneurs, especially the provision of small loans, acceptance of small savings deposits, and simple payments services needed by micro-entrepreneurs and other poor people (USAID, 2005). It is the provision of financial services to the economically active poor who are hitherto un-served by the mainstream financial service provide. Microfinance provides credit, savings and supervision services to women micro entrepreneurs. The poor women will use the credit to establish and manage their businesses to generate income or profit. The income realized will be used to provide basic needs to their households. In the context of this study, microfinance can be referred to as the issuance of small loans and other financial services to those who cannot get it from the traditional banks.

2.1.1 Roles of Microfinance Banks

The research conducted by Pollinger and Cordero (2007) revealed that microfinance banks, in their various formats, contribute to the reduction and alleviation of poverty and the promotion

of economic growth, especially in emerging nations. In Nigeria, they have advanced the government's poverty alleviation programs and backed promising businesses while assisting the emergence of new ones. The objectives of the microfinance banking scheme in Nigeria, which was developed in accordance with the Millennium Development Goals (MDGs), the National Economic Empowerment and Development Strategy (NEEDS), and the Vision 2020, firmly establish the role of microfinance banks in the promotion of national economic development. The function of microfinance banks may therefore be described as follows:

2.1.1.1 Deposit Mobilization and Promotion of Saving Culture: One of the demands of microfinance customers is a safe location to store their savings so that they may amass huge quantities of money to pay for stores, tools, housing, school fees, medical expenditures, weddings, funerals, etc. These demands are provided by the MFBs' actions to mobilize savings. Most micro businesses find it challenging to leave their stores and offices for banking transactions.

2.1.1.2 Credit Extension to Customers: Microfinance banks' major source of cash for expanding and starting enterprises is credit distribution. Microfinance banks focus on the poorest of the poor, organize borrowers into tiny homogeneous groups, and make loans to address varied development needs without collateral. Many microfinance banks offer loans for small businesses, entrepreneurs, hardcore poor, partnership building, and more. Governments encourage co-operatives to engage with microfinance banks to raise bulk loans for beneficiaries.

2.1.1.3 Employment Generation: MFBs also contribute immensely to job creation in the rural areas through the provision of skills acquisition and adult literacy programs. It has therefore been acknowledged that the rural setting is an arena of many industries and self-employed micro-enterprises, which could be empowered to contribute significantly to the national economy.

2.1.1.4 Entrepreneurship Promotion: The goal of microfinance is to encourage entrepreneurship and develop rural financial markets, which will give sustainable access to financial services by establishing a link between those with financial resources and those who need them. MFBs also aid economic development by providing ancillary capacity building to micro-enterprises in areas such as record keeping and small business management; collecting money or the proceeds of banking instruments on behalf of their customers through

correspondent banks; providing payment services such as salary, gratuity, and pension for the staff of micro-enterprises and various tiers of government; and providing loan disbursement services for the delivery of loans.

2.1.2 Microfinance bank Services

2.1.2.1 Micro-Credit

Micro-Credit is the small amounts provided as loans to the poor in order to empower them economically and encourage them to earn revenue through self-employment Karthikeyan and Senthilkumar (2021). Micro-Credit refers to a means of providing effective tools to resolve poverty issues by improving entrepreneurial activities, enhancing women's entrepreneurship and uplifting the education levels of women as well as men (Zahari et al., 2021). Micro-credit has been able to provide a role for many women in the economy which has resulted in conferring on them a worthwhile status in society and thus, it has been set up in order to aid poor people by lending small loans to them, as they are often rejected by conventional banks since they are considered to be unworthy of credit due to lack of a sound wage or collateral (Zahari et al., 2021). The term Micro- credit was first introduced in 1970 by Dr. Muhammad Yunus, professor of economics at the University of Chittagong, and describes the provision of loans to poor people to begin income-generating activities (Mia, 2022).

2.1.2.2 Micro-Savings

“Micro savings is a branch of microfinance, consisting of a small deposit account offered to lower income families or individuals as an incentive to store funds for future use. Micro savings accounts work similar to a normal savings account; they are, however, designed around smaller amounts of money (Benami and Carter 2021). The minimum balance requirements are often waived, or very low, allowing users to save small amounts of money and not be charged for the service. These Micro Savings are periodical savings which will help low-income people to maintain their savings routine with the aim of achieving long term goals such as education, retirement security, starting a business and building ownership (Benami and Carter 2021). Micro-savings incorporates these three ideas; it is savings made by poor or low-income people, it is savings which are held in institutions specialized for micro finance and it is a small quantity of savings thus, It can be considered an important means of accumulating assets and enhancing the future wellbeing of the underprivileged

(Karthikeyan and Senthilkumar 2021). Micro-Savings leads people to acquire assets and also assists in the expansion of their businesses. It further aids in long-term financial control which will facilitate the poor to build their future capabilities.

2.1.2.3 Micro-Insurance

Micro-Insurance provides coverage for low income people, who only have a small amount of money saved or have low household incomes, and it is given to compensate for injuries, illness or death as well as for loss of assets with low values Hameed et al., (2022). Similar to other types of insurance, Micro Insurance aids both property risks and health risks. Micro-Insurance is delivered mainly through four methods. These are; the partner-agent method, the full-service mode, the provider-driven model and the community-based method Chandrarathna and Sumanasiri, (2021).

Micro-Insurance comprises two aspects, which are; what is included in insurance and what is term “Micro” in Micro-Insurance. The above study emphasizes several common features which are included in the concept of Micro Insurance. They are that Micro-Insurance is suitable for people who are earning low incomes, it applies the concept of risk pooling, it can be considered as independent from the class of risk and it mainly targets people who are in the informal sector (Birech 2023). Micro-Insurance, which was introduced later with the advancement of the Micro-Finance sector, is considered as an additional service provided by Micro-Finance institutions rather than merely catering to the basic needs of underprivileged persons (Loewe, 2021). Also, Micro-Finance institutions have initiated these insurance schemes in order to recover the payments which have not been made by Women Entrepreneurs in serious cases. Micro Insurance is considered as a mode which helps in protecting people with low incomes against risks such as illnesses, accidents, natural disasters etc. and the insurance premium is based on these people’s income, risk levels and needs, it also provides less privileged people the means for protecting against risks, since low income people and small and medium businesses are always vulnerable to risks (Loewe, 2021). Therefore, micro-Insurance can be considered as a tool that protects the larger society as well.

2.1.2.4 Business support

The relevance of microfinance support on SMEs’ development cannot be over emphasized. it is widely believed that microfinance is an imperative enabler for the establishment, survival,

and development of SMEs. According to OECD (2015), broadened access to finance for SMEs leads to about an average of 60% of start-ups to survive their first three years of operation. In a similar vein, Atmadja, et al. (2016) stress that financial capital is positively related to the development of the businesses, emphasizing that it allows entrepreneurs to invest in prolific projects and exploit more business opportunities. Contrariwise, other studies including Adejimola and Olufenmilayo (2009), and Oni, et al. (2012), contend that the SMEs' progression specifically in Nigeria is mainly deterred by lack of follow-up support by the microfinance institutions in the country but not necessarily by inadequate access to finance. Business support encompasses a wide range of services and resources, including financial assistance, mentorship, training, networking, regulatory guidance, and more, provided to businesses, especially SMEs, to help them start, grow, and succeed. Lastly, Atmadja et al. (2016) illuminate in their study that microloan or other micro facilities as a sole assistance does not really guarantee a boost in business performance. Therefore, complementing it with non-financial factors such as education or training leads to exceptional growth. However, training offered by the microfinance institutions (MFIs) in Kenya show an inverse relation to that (Kisaka and Mwewa, 2014). These diverse results of the empirical studies are substantiations that the impact of microfinance support on the survival and/or business development of SMEs is paramount. There are various ways in which SMEs utilise the acquired microfinance support to boost their chances of business development. This is influenced by the specific purpose for acquiring that particular support. Empirically, the study of Banerjee et al. (2013), uncovers that the provision of microfinance support to the needy SMEs in Hyderabad, India did not result in new creation of SMEs. However, it has resulted in business expansion of the existing ones. In Uganda, microfinance delivery has led to a progressive impact on new product development, improvement of existing products and business expansion (Morris & Barnes, 2005). These differing approaches drive to a conclusion that the utilization of microfinance support to expand businesses varies between firms and countries, depending on their needs.

3.0 SMEs Growth

The word performance is vague, there is no consensus on fundamental terms, and there is no clear description and dimension to determine a company's performance and these further compounds the subject area for management researchers (Maley and Moeller 2021). Performance has numerous names, including development, survival, success and

competitiveness as a multidimensional construct. There is a lack of generality of view on the idea of what makes up business success, as success is seen primarily within the entrepreneur's subjective lens. SME accomplishments have typically been divided into financial and non-financial elements (Amin, 2021). Financial performance includes a wide range of metrics such as profits, sales, return on investment, etc., while non-financial measures for SMEs success include continuous business processes for a period of three years, personal engagement and autonomy, work-life balance (Amin, 2021). There are multi-faceted determinants of SME performance/success in Nigeria. Performance generally can be defined as the ability of the firm to achieve satisfactory results and behavior (Amin, 2021). Business growth can be viewed as a matrix of business performance, where multiple dimensions and factors intersect to influence the overall development and success of a company. This matrix typically involves several key aspects that interact and contribute to the overall growth trajectory of a business (Maley and Moeller 2021). The dimensions of business growth as it relates to business performance are discussed as thus:

Financial Performance: This dimension focuses on the company's financial health, including factors such as revenue growth, profitability, and cash flow. A business with strong financial performance is more likely to invest in growth initiatives and withstand economic challenges.

Market Expansion: The Company's ability to enter new markets, expand its customer base, and diversify its product or service offerings. Market expansion is a critical factor in achieving sustainable growth.

Operational Efficiency: Efficient operations help control costs, improve productivity, and deliver products or services more effectively. Streamlining operations can free up resources for growth activities.

Innovation and Product Development: Businesses that continually innovate and develop new products or services can capture new market opportunities and stay competitive in a rapidly changing business environment.

Customer Satisfaction and Retention: Maintaining and growing a satisfied customer base is essential. Loyal customers can drive repeat business and referrals, contributing to sustainable growth.

Human Resources and Talent: The quality of the workforce, their skills, and their alignment with the company's goals significantly impact business growth. Talent acquisition, retention, and development are crucial in this dimension.

Technology and Digital Transformation: Embracing technology and digital solutions can enhance efficiency, customer engagement, and competitiveness, fostering business growth in today's digital age.

Risk Management and Resilience: How well a business identifies and manages risks, including financial, operational, and market risks, can influence its ability to adapt and grow in the face of challenges.

Regulatory Compliance: Adherence to legal and regulatory requirements is essential. Non-compliance can lead to fines or disruptions that impede growth.

Partnerships and Alliances: Collaborations with other businesses, suppliers, or industry partners can open up new opportunities, access to resources, and distribution channels.

Sustainability and Corporate Social Responsibility (CSR): Businesses that prioritize sustainability and CSR can appeal to socially conscious consumers and investors, potentially fueling growth.

Access to Funding and Capital: The availability of financing options, such as loans, equity investments, or grants, can significantly impact a company's capacity for growth and expansion.

Brand and Reputation Management: A strong brand and a positive reputation can attract customers and partners, making it easier for a business to grow and expand.

Strategic Planning and Vision: The clarity of a business's strategic vision and the effectiveness of its planning processes play a crucial role in shaping its growth trajectory.

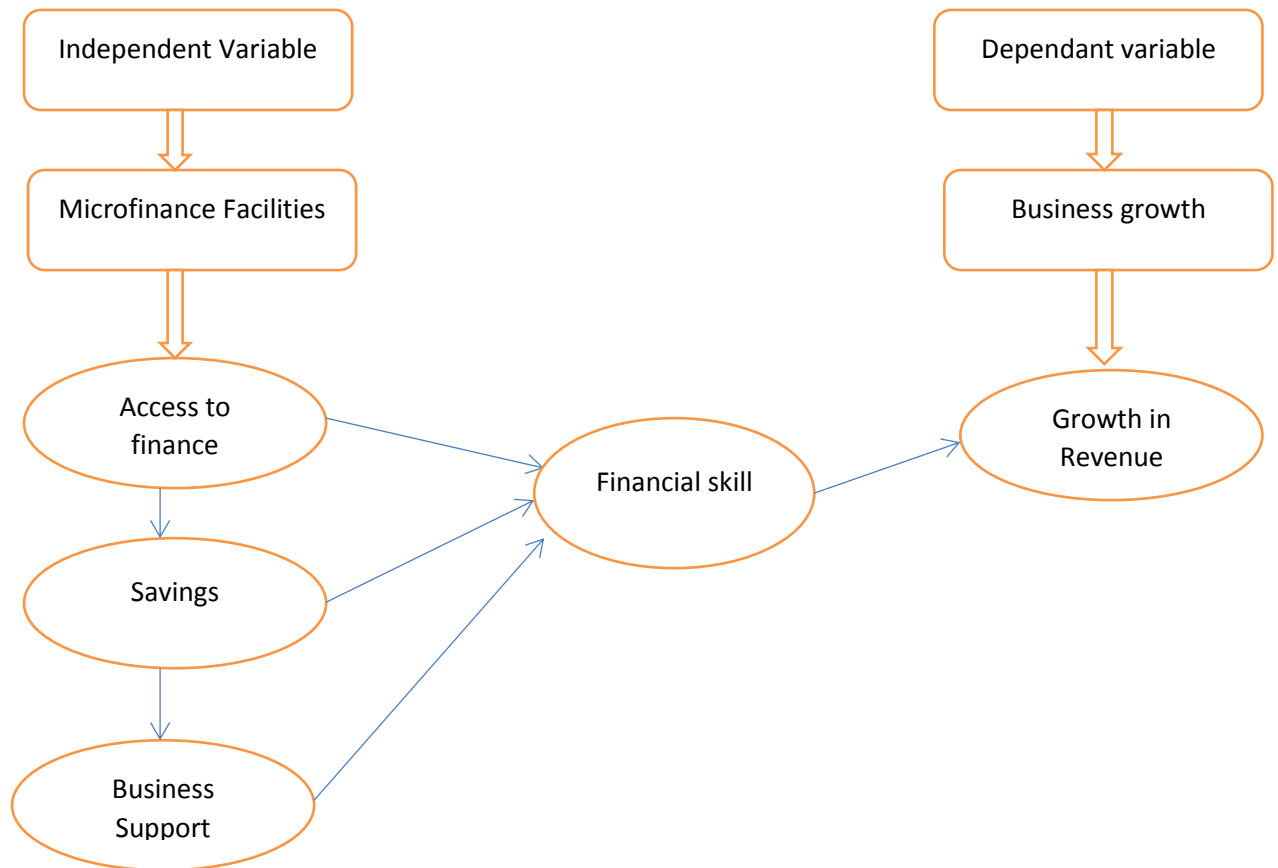


Figure 1: Conceptual Framework for the study

Figure 1 above represents the conceptual framework for the study, as shown, Microfinance facilities was conceptualized into three important proxies that is access to finance, savings as well as business support rendered to this trade and retail SMEs, these proxies are expected to impact on their growth in revenue through the mediating effect of financial skill of the owners or managers of these group of SMEs.

4.0 Literature Review

Onyeiwu et al. 2021 in his study titled the influence of Microfinance Bank Services on the performance of MSEs in Kaduna State, Nigeria. The main purpose of the study is to examine the influence of Microfinance Bank Services on the performance of Micro and Small enterprises in Kaduna State. The study adopted descriptive survey research design. The population of this study comprise 3,802 registered MSEs operating in Kaduna State. 388 MSEs were sampled in Kaduna State; 112 from Northern Kaduna, 170 from Central Kaduna and 106 from Southern Kaduna. The data collected to answer the research questions were

analyzed using mean and standard deviation. Hypotheses were tested using Analysis of variance (ANOVA) because the groups are more than two. The findings reveal among others that Micro-finance bank loan influences the performance of MSEs to low extent, Micro-finance bank savings influences the performance of MSEs to high extent and there was no significant difference among the mean ratings of MSEs (Farming/Agriculture, Manufacturing/Production, Services and Trading) on the extent to which micro-finance loan influences the performance of MSEs. Based on the findings it was concluded that the SME's in Kaduna State do not utilize the micro finance institutions insurance services and hence are easily exposed to disasters which might hinder their development. Following the conclusion, it was recommended among others that Micro-finance Banks management need to diversify their insurance portfolio to cover a wider scope of MSEs needs and operation and there need to be a policy that all people engaged in MSE's must undergo some micro finance Banks training before they are issued with a business license.

Ofeimum et al. (2018) in their collective effort sought to examine the relevance of micro-financing of small businesses in Nigeria. Data analytical method chosen was the ordinary least squares method and nature of data is time-series extracted from Nigerian-based MFBs and Central Bank of Nigeria. Findings pinpoint that there is a negative relationship between inflation and small business growth; micro lending rate has an insignificant and negative relationship with small business growth; sectoral spread of micro loans has a significant effect on the growth of small businesses in Nigeria and micro loan gestation period had no significant relationship with small business growth for the period under review

Musti and Mallum (2020) in their study the impact of loan repayment of microfinance bank to the performance of SMEs in Adamawa state. This research investigated the impact of Microfinance bank on the performance of selected small and medium enterprises, SMEs in Adamawa State. The study also determined how Microfinance banks activities were used in loan repayment, loan duration as well as collateral security required in obtaining a loan from a microfinance bank. The study made use of survey design and used both primary and secondary data. A simple random sampling technique was used to select the 346 sample size. The data were analyzed using descriptive statistical techniques. Four hypotheses formulated were developed around the theories of financial growth perking order theories. The scope of the study covers a period from 2010 to 2018. The major finding shows that a significant relationship exists between Microfinance bank and SMEs performance in Adamawa state.

The result shows that loan repayment, loan duration and collateral security of Microfinance bank have a positive impact on SMEs performance in Adamawa state. The study recommends that the Microfinance banks and government should soften the borrowing condition and also to increase the capital base of Microfinance banks to service more entrepreneurs.

Denis et al. 2022 investigated the relationship between Microfinance Saving Services and SMEs Growth in Kenya: A Case Study of Manyatta Sub Location, Kisumu, Kenya. The study specific objective was to establish the relationship between microfinance saving services and Small and Medium Enterprises' growth in Manyatta Sub-County-Kisumu County. The research was anchored on the classic microfinance theory of change. The study employed correlation research design. Data was analyzed using Pearson's correlation analysis, with a population size of 2500 small and medium enterprises. Using probability sampling technique, a sample size of 71 respondents was drawn from owners of the small and medium enterprises. Primary data was collected by administering questionnaires, observations and interviews and secondary data was collected from relevant books, journals and periodicals. Data was presented using frequency tables. The data was for the period 2011 to 2015. The test-retest coefficient was obtained to establish reliability of the research instruments as established by Fishers' 0.7 coefficients. The study concluded that there exist a positive effect of Microfinance saving services on the growth of small and medium enterprises in Manyatta Sub-County in Kisumu County, Kenya. The study recommends MFIs to offer financial training to assist SMEs in understanding the importance of savings to scale up economic growth. The study also recommends further research to establish more facts between savings and economic growth.

Ingabire and Ogoi, (2021). In their study Effect of microfinance loan on poverty reduction in Rwanda. The purpose of this study was to investigate the effect of microfinance loan on poverty reduction in Rwanda. The study sought to identify the achievements of microfinance loans to the individuals, explore the perceptions of microfinance beneficiaries on poverty reduction and determine the effect of microfinance loans on the economic growth. The target population for this study was 6228 persons, which included employees and clients of COPEDU PLC, Remera Branch. The study adopted descriptive research design to collect data from the selected sample size. The primary data was collected using questionnaires that were randomly distributed to the sample population. The data collected was analyzed using

the Statistical Package for Social Sciences (SPSS) software to determine the mean, mode, standard deviation and inferential statistics related to the study. The findings from the study indicate that microfinance loans have a significant effect on poverty reduction. The study found that microfinance loans empower the poor and enable them to overcome the challenges that they face. The provision of microfinance loans has led to start-ups, growth and expansion of micro and small businesses resulting in asset building, job creation, poverty reduction and improved standard of living. The study concludes that provision of microfinance loans have a significant effect on poverty reduction in Rwanda. This study recommends that the microfinance management review the loan processing requirements to facilitate the application process and induce more people to take the loans. The study also recommends that management consider providing a grace period to enable the borrowers to make proper arrangement on how to repay the loans.

Ngonyani (2020). In his study Loan Appraisal Protocol for Effective Microfinance Portfolio in Tanzania. This paper attempts to determine the effects of loan application appraisal on microfinance institutions' portfolio performance in Tanzania. The study utilizes a random sampling method and ordinary least square regression model on 219 microfinance entities collected from Dar es Salaam, Morogoro, and Dodoma regions. The finding indicates borrower business income, capital of borrower, membership duration of the borrower, and social collateral of borrowers negatively and significantly influences portfolio at risk of microfinance entities. These results, therefore, reveal that (i) microfinance institutions can reduce microfinance portfolio at risk to consider sound cash flow of the main business of microfinance client to enhance repayments; (ii) microfinance institutions must provide credit facilities to borrowers with relatively high capital in their business; (iii) microfinance institutions should extend credits to borrowers who are frequently willing to access credit facilities to enhance regular repayments; (iv) microfinance institutions should encourage borrowers to use group lending when accessing credits for effective repayments and diminish the risk of the microfinance loan portfolio. The review of extant studies involving the study's main variables highlighted two important gaps, that is conceptual gap and methodological gap. Firstly, the conceptual gap relates to the fact that despite the importance of financial skill of SMEs owners or managers in achieving higher performance, none of the studies reviewed access its mediation between the offerings of micro finance institutions and the performance of SMEs. Considering this important gap, this study seeks to investigate the effect of

Microfinance services and the performance of retail and trade SMEs through the mediating role of financial skill of the retail and trade SMEs owners and managers. Secondly, methodological gap was also identified, the review of extant studies in this area has highlighted that over 60% of the studies assessed this relationship via the employment of Multiple regression and in industries other than retail and trade, to this effect, this study seeks to bridge this gap by investing the trade and retail SMEs specifically through the use of Multiple-regression.

5.0 Methodology

The study adopted a survey research method using a quantitative approach to survey the registered retail and trade outlet with microfinance bank Minna. This population is 2,436 as stated in Microfinance institution. In calculating the sample size of the study, Taro Yamane formula was applied because of its vast usage in research based on an acceptable margin of error of 5% arriving at 344 SMEs and collected data using structured question on 5-point Likert scale. The collected data was analyzed using multiple regression technique on SPSS 21.

6.0 Findings

Table 6.1: Regression Analysis for the Effect of Microfinance Services on SME Performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.249	0.062	0.054	1.058
2	0.262	0.068	0.060	0.735
3	0.775	0.601	0.600	0.688
4	0.778	0.606	0.601	0.687

Source: Researcher's Fieldwork, 2024.

Table 6.1 show the results of a regression analysis that examines the effect of microfinance services on Small and Medium Enterprises (SMEs) performance. The table summarizes the regression results, with each row representing a different model that tests independent variables or model specifications.

The "Model" column distinguishes the various models tested in the regression analysis. The correlation coefficient (R) showcases the strength and direction of the linear relationship between the independent variable (microfinance services) and the dependent variable (SME

performance). In this context, it reveals how well microfinance services correlate with SME performance. Model 1 shows a weak positive correlation between microfinance services and SME performance, with an R value of 0.249.

The R Square (R^2) measures the proportion of variance in SME performance that can be explained by microfinance services. It ranges from 0 to 1, with higher values indicating a better fit of the model to the data. In Model 1, the R Square is 0.062, suggesting that only 6.2% of the variance in SME performance can be explained by microfinance services. The Adjusted R Square adjusts the R Square value based on the number of predictors in the model, providing a more accurate estimate of the proportion of variance explained. It penalizes the inclusion of irrelevant predictors in the model. In Model 1, the adjusted R Square is 0.054, emphasizing the impact of considering the number of predictors.

The Standard Error of the Estimate represents the standard deviation of the residuals, which are the discrepancies between the observed and predicted values of the dependent variable. It serves as a measure of the accuracy of the predictions made by the regression model. Smaller values of the standard error of the estimate reflect higher predictive accuracy. In Model 1, the standard error of the estimate is 1.058, indicating a relatively small margin of error.

As we move from Model 1 to Model 4, we observe a gradual improvement in the R Square and Adjusted R Square values, indicating better fits of the models to the data. This suggests that the inclusion of additional variables or refinements in the model enhances its explanatory power for SME performance. Model 4 exhibits the highest R Square and Adjusted R Square values among the presented models, indicating the most optimal fit. Overall, this table and analysis provide valuable insights into the relationship between microfinance services and SME performance, highlighting the importance of additional predictors in enhancing the model's explanatory power.

4.3.3 Coefficients for the Regression Models

Table 6.2: Coefficients for the Regression Models

Model	Variable	Unstandardized Coefficient	Standardized Coefficient	t	Sig.
1	Constant	3.908		20.729	0.000
1	Savings	0.005	0.005	0.046	0.964

1	Business Support	0.340	0.331	3.129	0.002
1	Access to Finance	0.107	0.107	1.104	0.270
2	Constant	3.559		26.282	0.000
2	Access to Finance	-0.047	0.064	0.597	0.551
2	Savings	0.106	0.145	1.246	0.214
2	Business Support	-0.243	0.325	-2.941	0.003
3	Constant	0.331		2.491	0.013
3	Financial Skills	0.948	0.775	22.597	0.000
4	Constant	0.478		2.382	0.018
4	Savings	0.006	0.006	0.089	0.929
4	Business Support	0.119	0.116	1.675	0.095
4	Access to Finance	0.091	0.091	1.452	0.147
4	Financial Skills	0.932	0.762	21.532	0.000

Source: Researcher's Fieldwork, 2024.

The coefficients presented in Table 6.2 are a critical component of the regression analysis that aims to examine the relationship between independent variables and Small and Medium Enterprises (SMEs) performance. The table consists of four different models, each incorporating different independent variables that enable a comprehensive exploration of their relationship with SME performance. The unstandardized coefficients provide valuable insights into the direction and strength of the relationship between each independent variable and SME performance. They indicate the change in SME performance for a one-unit change in each independent variable, while keeping all other variables constant. The standardized coefficients, on the other hand, help to assess the relative importance of each independent variable to SME performance, considering their respective scales.

The t-statistic and p-value are instrumental in determining the significance of each coefficient. A higher absolute value of the t-statistic implies a more significant coefficient, while a p-value lower than the predetermined significance level indicates a statistically significant coefficient. These statistical measures help researchers and policymakers identify the independent variables that have the most significant impact on SME performance.

The constant term, also known as the intercept, remains unchanged in each model and represents the starting point of the regression line where all independent variables are set to zero. The coefficients corresponding to each independent variable provide valuable insights into their respective impacts on SME performance. Model 1 incorporates three independent variables, Savings, Business Support, and Access to Finance. Model 2 and Model 4 are similar to Model 1, with additional independent variables, while Model 3 focuses solely on Financial Skills. The coefficients for each independent variable in each model provide researchers and policymakers with a detailed understanding of the factors that drive SME performance.

Overall, the coefficients presented in Table 4.4 are critical in understanding the intricate relationships between independent variables and SME performance. The analysis provides valuable insights into the factors that contribute to the success of SMEs and helps policymakers make informed decisions to promote SME growth and development. By examining the coefficients in each model, researchers and policymakers can identify key areas of focus and tailor their policies and strategies to enhance SME performance

6.2 The Mediating Role of Financial Skill on The Relationship Between Microfinance Services and Performance of SMES In the Study Area

Table 6.3 Mediation Analysis

Step	Analysis	Independent Variable	Mediator	Dependent Variable	Coefficient (β)	Sig.
1	Regression	Access_to_Finance	-	Growth	0.107	0.270
		Savings	-		0.005	0.964
		Business Support	-		0.340	0.002
2	Regression	Access_to_Finance	-	Financial Skill	0.107	0.270
3	Regression	Financial Skill	Access_to_Finance	Growth	0.948	0.000
4	Mediation Analysis	Access_to_Finance	Financial Skill	Growth	-	-

Source: Researcher's Fieldwork, 2024.

Table 6.3 illustrates the outcomes of a regression and mediation analysis that was conducted in order to explore the correlation between microfinance services and the performance of Small and Medium-sized Enterprises (SMEs) within a specific study area. The primary

objective of this study was to examine the mediating role of financial skills in this particular relationship. In order to achieve their objective, the researchers carried out numerous regression and mediation analyses. Initially, a regression analysis was performed to investigate the direct impacts of access to finance, savings, and business support on the growth of SMEs.

The results from the evaluation of the regression coefficients (β) and significance levels (Sig.) of each independent variable, yielding the following outcomes: - Access to Finance: $\beta = 0.107$, Sig. = 0.270 (not significant) - Savings: $\beta = 0.005$, Sig. = 0.964 (not significant) - Business Support: $\beta = 0.340$, Sig. = 0.002 (significant) The results indicated that only business support had a significant positive effect on the growth of SMEs. Conversely, access to finance and savings did not display a significant direct impact on SME growth. Furthermore, another regression conducted shows the direct effect of access to finance on financial skills. The outcome of this analysis revealed that access to finance did not exert a significant direct impact on financial skills.

Additionally, a regression analysis was employed to examine the direct effect of financial skills and access to finance on SME growth. The findings demonstrated that financial skills displayed a substantial positive influence on SME growth. Additionally, the mediation analysis was carried out to explore the mediating role of financial skills in the relationship between access to finance and SME growth. Although the coefficient (β) for the relationship between access to finance and SME growth was not specified, the outcome suggested that financial skills potentially acted as a mediator in this relationship.

Overall, the findings of the study indicated that access to finance alone does not exert a significant impact on SME growth. However, business support and financial skills play a crucial role in enhancing the performance of SMEs. Notably, financial skills mediate the relationship between access to finance and SME growth, thus highlighting the fundamental importance of possessing adequate financial knowledge and expertise for SMEs to effectively leverage the benefits of microfinance services. Based on these significant findings, the study strongly recommends that initiatives aimed at improving SME performance should not solely concentrate on providing access to finance. Instead, these initiatives should also prioritize efforts to enhance financial literacy and skills among SME owners and managers. By adopting this comprehensive approach, it is highly likely that the study area will observe

better outcomes in terms of SME growth and sustainability. Consequently, the study places great emphasis on the criticality of developing financial skills among SMEs to enable them to effectively utilize the microfinance services that are available to them. The findings of the study indicate that the demographic distribution of the participants shows a slightly higher presence of male individuals, accounting for 54% of the sample, while female participants constitute the remaining 46%. In terms of age groups, individuals aged 20-39 represent 49% of the respondents, whereas those aged 40-59 make up 38.7% of the participants, with the majority (over 87%) falling within the age range of 20 to 59. The largest group consists of married individuals, comprising 55.7%, followed by single individuals at 28.7%, with divorced individuals accounting for 13.2% and 2.3% classified under "others."

Furthermore, the majority of participants possess at least an HND/BSC qualification, amounting to 45.5% of the total. Those who completed their SSCE make up 13.8%, while individuals with an OND represent 23.5%. Additionally, 12.9% of the participants achieved a master's degree, and 4.4% possess other certifications.

Moreover, the respondents are categorized into three distinct groups: producers (35.8%), processors (45.2%), and marketers (19.1%). Based on the mean value, the study suggests that there is a moderate level of accessibility, which exhibits considerable variability among respondents. The level of savings is also moderate, with significant variability. The perception of support for business endeavors is moderately perceived, with noticeable variability. Similarly, the perception of growth potential is moderate, with variability among respondents. Moreover, participants rate their financial skills slightly below the midpoint of the scale, displaying less variability compared to other variables.

The initial models indicate weak correlations between microfinance services and SME performance, with only business support showing significant positive effects. The impact of savings and access to finance on SME growth is not found to be significant.

However, it is observed that financial skills have a substantial positive influence on SME growth, acting as a mediator in the relationship between access to finance and SME growth.

Therefore, the study recommends focusing on improving financial literacy and skills among SME owners and managers, in addition to providing access to finance, to effectively enhance SME performance.

These findings underline the importance of considering factors beyond access to finance, such as business support and financial skills, in promoting SME growth and sustainability. It is emphasized that enhancing financial literacy and skills is a critical aspect to effectively leverage the benefits of microfinance services.

7.0 Recommendation

The study therefore makes the following key recommendations to business owners;

- i. considering that access to credit does not show a significant effect on the performance of SMEs in Niger state, it is recommended that policymakers and microfinance institutions revisit and possibly refine their credit delivery mechanisms. Exploring alternative financial instruments or improving the accessibility of credit in a more tailored manner to the specific needs of SMEs in the region could enhance the impact of microfinance services on business performance.
- ii. Considering that business support demonstrates a positive and significant effect on the performance of SMEs in Niger state, it is advisable for microfinance institutions and relevant stakeholders to continue and even expand their efforts in providing comprehensive business support services. This could involve mentorship programs, training workshops, and consultancy services aimed at enhancing the managerial and operational capacities of SMEs, thereby fostering sustainable growth and success.
- iii. despite the finding that savings does not have a significant effect on SMEs' performance in Niger state, it is essential to encourage and educate SMEs on the potential benefits of saving for future investments and contingencies. Microfinance institutions could introduce innovative savings products or financial literacy programs to enhance the understanding and appreciation of saving practices among SMEs in the region.
- iv. Recognizing that financial skills mediate the relationship between microfinance services and SMEs' performance, it is recommended that microfinance institutions prioritize financial literacy programs. These programs should focus on equipping SME owners and managers with the necessary skills to effectively manage their finances, make informed decisions, and maximize the benefits of microfinance services. Strengthening financial skills can enhance the overall impact of microfinance interventions and contribute to the sustained growth of SMEs in Niger state.

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IMPACT OF ENTREPRENEURSHIP ON REDUCTION OF UNEMPLOYMENT IN NIGERIA

BY

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ABSTRACT

This study addresses the pressing issue of unemployment in Nigeria, focusing on the impact of entrepreneurship in alleviating this economic challenge. It analysed the role of entrepreneurship, particularly within Small and Medium Enterprises (SMEs), in reducing unemployment. The research employs annual time series data from 1991 to 2021 and the Auto Regressive Distributed Lag (ARDL) method. Findings reveal a significance relationship between entrepreneurship and unemployment. Specifically, SMEs while being significant contributors to economic activities, exhibit a significant impact on the reduction of unemployment. Additionally, government expenditure on education and health emerged as crucial factors in decreasing the unemployment rate in Nigeria. In conclusion, the study underscores the complex dynamics involved in the relationship between entrepreneurship and unemployment in Nigeria. SMEs contributed substantially to reducing unemployment, as well as the positive influence of government expenditure on education and health in Nigeria. The study recommends for a comprehensive approach to entrepreneurship development, emphasising the need for targeted policies that enhances job creation potential of SMEs. Furthermore, the study suggested increase focus on government investment on education and health sectors for fostering sustainable reductions in unemployment rates. These insights will contribute to informed policies formulation on economic growth to address unemployment in Nigeria.

KEYWORDS: Entrepreneurship, Unemployment, Government expenditure, Education, Health

INTRODUCTION

Nigeria had a thriving entrepreneurial culture at the pre-colonial era, and unemployment was a rare phenomenon. However, like other developing countries, after gaining the independence, Nigeria faced a range of challenges including poverty, unemployment, conflicts etc. These issues resulted to significant threats to the well-being and livelihoods of individuals in the country. In response, there was an increasing recognition of the importance of training and educating the masses to effectively contribute to societal development. It was believed that people would be better prepared to tackle issues such as unemployment, poverty, conflicts etc if properly educated. Thus, education became a key factor in Nigeria's development efforts (Ikon and Chika, 2018). However, the nature of education was mostly preparing graduates to take up jobs as workers rather than employers of labour. This resulted to tremendous unemployment and a modern-day mania for readymade jobs.

However, entrepreneurship is expected to contribute to reducing unemployment by creating new job opportunities through the establishment and growth of businesses. Start-ups businesses are often cited as significant contributors to employment, as they tend to be labour-intensive. Entrepreneurship can also lead to skill development, innovation, and economic diversification, which can indirectly impact employment rates (O'Leary, 2022). The current study is predicated on the idea that entrepreneurship should be promoted in order to maintain a low-unemployment economy. More so, Nigeria is blessed with several commerce and investment possibilities including science, technology, academia, commerce, and entertainment (O'Leary, 2022). Notwithstanding the reality that entrepreneurship has been identified as the foundation for job creation and technological innovation in Nigeria, the sector has not received the desire attention, with severe effects on the economy.

Despite efforts by successive governments to address the issue of unemployment, the problem persists. The associated problems have hindered the country's ability to create a strong economic environment. Coincidentally, Nigeria has one of the highest unemployment rates globally (NBS, 2022). The motivation behind this study stems from the critical need to address the pervasive issue of unemployment, which poses significant challenges to economic growth and social well-being. The current study will investigate the questions:

- (i) What is the impact of SMEs on the reduction of unemployment in Nigeria?
- (ii) What is the impact of education expenditure on the reduction of unemployment in Nigeria?
- (iii) What is the impact of health expenditure on the reduction of unemployment in Nigeria?

2) Literature Review

This section of study presents the concept of entrepreneurship, theoretical framework and empirically reviewed relevant literatures. Thus, entrepreneurship is conceived as an individual's or group's aptitude and attitude towards initiatives with the potential for success or failure. It is a dynamic process of vision change and creation of limitless opportunities. On the other hand, the unemployment refers to the state where individuals who are actively seeking employment but are unable to find suitable jobs.

Theoretically, entrepreneurial ecosystem framework provides a comprehensive understanding of the various factors and dynamics that contributed to the creation and growth of entrepreneurial activities within an economy. Such as the interplay between different stakeholders, institutions, and resources that shape the entrepreneurial environment. Entrepreneurship acts as a catalyst for job creation and economic development. It suggests a supportive ecosystem that encourages entrepreneurship that can lead to the generation of new ventures, which in turn, create employment opportunities. Several elements within the entrepreneurial ecosystem can influence employment generation: Access to capital, entrepreneurial culture and mind-set, supportive institutions, regulatory environment.

Empirically, the causal link between entrepreneurship and unemployment has been explored. For example, Ogunjimi (2021) assessed the importance of SMEs in addressing unemployment. Findings revealed that employment provided by SMEs have beneficial effect on unemployment. Peter and Oghuvwu (2020) investigated the significance of SMEs on job creation and socioeconomic development in the Niger Delta region. Findings showed that creation of SMEs would create jobs and contribute to socioeconomic development. Similarly, Umoghai et al, (2018) conducted a primary study on entrepreneurship education and unemployment reduction. It reported that entrepreneurship education had significantly contributed to unemployment reduction. However, study data was limited to Vandeikya Local Government Area of Benue State. Sunday and Miriam (2015) assessed the capacity of entrepreneurship in Nigeria to generate employment and sustainable development using secondary data from 1980 to 2013. The Johansen co-integration test revealed that employment and average capacity utilisations were statistically significant, indicating that entrepreneurship may offer employment and capacity utilisation for long-term growth.

Likewise outside countries, Meyer and Meyer (2020) investigated the connection between entrepreneurship, job opportunities, and domestic capital investment in five European nations employing data from 2001 to 2019. A fully modified OLS was used to assess both short and long-run connection between variables. Findings revealed a long-run link among the variables. New and existing businesses were discovered to be significant predictors of employment and domestic investment. Also, Asad et al. (2014) investigated the necessity for lowering unemployment in Pakistan through entrepreneurship. The regression results of explanatory variables explain 91% of the variation in entrepreneurship development. It has been discovered that the unemployment rate was inversely related to entrepreneurial

development. Thus, high unemployment was linked to a lack of entrepreneurial development in Pakistan's economy.

However, some gaps in literature were identified. While some of the studies were foreign, those that were conducted in Nigeria used variables different from the ones in this study. Similarly, most of the studies were limited in scope. For instance, Umoghai et al, (2018) use data from Vandeikya Local Government Area only. The current study focused on Nigeria as a whole.

3) Methodology

The current study addresses the pressing issue of unemployment in Nigeria. It focused on the impact of entrepreneurship in alleviating economic challenge. The study analysed the role of entrepreneurship, particularly within Small and Medium Enterprises (SMEs), in reducing unemployment. The entrepreneurship was proxy through the number of SMEs, government spending on education and health. Government spending on human capital development is necessary for nurturing entrepreneurship (Umar et al, 2020). This study employs annual time series data from 1991 to 2021. The data were generated from Statistical Bulletin of Central Bank of Nigeria (CBN, 2022) and the World Development Indicators (World Bank, 2023). The study employed Augmented Dickey Fuller (ADF) and Philips-Perron (PP) unit root tests to examine stationarity and integrated order of the variables. Autoregressive Distributed Lag (ARDL) was used to investigate for the existence of co-integration relationship among the variables, and ARDL-ECM approach was used to estimate the coefficients of both the short-run and long-run relationship.

4) Data Analysis

Descriptive Statistics

Table 4.1: Results of Descriptive Statistics

Variables/Stat.	LNUNEM	LNSMES	LNGEXE	LNGEXH	LNGDP	LNPOP	LNGFCF
Mean	1.408	18.406	4.307	3.610	7.581	3.970	3.236
Median	1.360	12.877	4.779	4.131	7.608	3.969	3.264
Maximum	1.792	72.836	6.472	6.048	7.893	3.984	3.880
Minimum	1.308	5.388	-1.233	-1.896	7.265	3.955	2.651

Std. Dev.	0.131	16.517	1.892	2.081	0.237	0.008	0.401
Skewness	1.903	2.128	-1.103	-0.863	-0.115	-0.013	-0.080
Kurtosis	5.487	6.423	3.838	2.928	1.351	2.018	1.667
Jarque-Bera	26.694	38.530	7.193	3.857	3.579	1.246	2.328
Probability	0.000	0.000	0.027	0.145	0.167	0.536	0.312
Observations	31	31	31	31	31	31	31

The descriptive statistics in Table 4.1 showed that the unemployment rate (UNEM) exhibits an average value (mean) of 1.408. The distribution of UNEM was positively skewed (1.903), while the kurtosis value of 5.487 indicated a relatively peaked shape compared to a normal distribution.

The number of Small and Medium Enterprises (SMEs) exhibits an average value of 18.406, and positively skewed (2.128), indicating a longer right tail in the distribution. The kurtosis value of 6.423 indicated a relatively peaked shape compared to a normal distribution. In the case of government expenditure on education (GEXE), its mean value was average (4.307), and the distribution was positively skewed, with a skewness value of -1.103, indicating a longer right tail. However, the kurtosis value of 3.838 suggests that the distribution is less peaked compared to a normal distribution. Similarly, government expenditure on health (GEXH) had a mean value of 3.610. The distribution of was also skewed (-0.863), indicating a longer right tail. The kurtosis value of 2.928 further suggested that the distribution was less peaked compared to a normal distribution. The Gross Domestic Product (GDP) mean value was 7.581, nearly symmetric around the mean, with a skewness value of -0.115. Furthermore, the kurtosis value of 1.351 suggests a distribution that was less peaked compared to a normal distribution. Yet, the population size of the labour force as a percentage of the total population mean value was 3.970, also, nearly symmetric around the mean, as indicated by the skewness value of -0.013. While the kurtosis value of 2.018 suggested a distribution that was less peaked compared to a normal distribution. Lastly, for the variable GFCF, with a mean value of 3.236% of GDP, reflecting the average value for this specific variable. The distribution of GFCF is positively skewed, as evident from the skewness value of -0.080,

indicating a longer right tail. Furthermore, the kurtosis value of 1.667 suggests a distribution that is less peaked compared to a normal distribution.

Correlation Matrix

The results of correlation matrix are presented in table 4.2. The correlation coefficient was -0.646, and the associated p-value was 0.002. This negative correlation suggests that as the number of small and medium enterprises increases, the natural logarithm of unemployment tends to decrease. The relationship is moderately strong, and the p-value indicates statistical significance.

For government expenditure on education: The correlation coefficient was -0.406, and the associated p-value was 0.024. This negative correlation implies that higher government expenditure on education was associated with lower levels of unemployment. Although the correlation is moderate, the p-value suggests statistical significance.

In the case of government expenditure on health: The correlation coefficient was -0.417, and the associated p-value was 0.020. Similarly, higher spending on health is negatively correlated with unemployment. The correlation was moderate, and the p-value indicates statistical significance.

Table 4.2: Results of Correlation Matrix

Variables	LNUNEM	LNSMES	LNGEXE	LNGEXH	LNGDP	LNPOP	LNGFCF
LNUNEM	1.000						
LNSMES	-0.646 (0.002)	1.000					
LNGEXE	-0.406 (0.024)	0.563 (0.001)	1.000				
LNGEXH	-0.417 (0.020)	0.563 (0.001)	0.992 (0.000)	1.000			
LNGDP	-0.398 (0.027)	0.451 (0.011)	0.815 (0.000)	0.856 (0.000)	1.000		
LNPOP	0.363	0.267	0.283	0.236	-0.207	1.000	

	(0.045)	(0.147)	(0.123)	(0.201)	(0.265)		
LNGFCF	-0.027	0.478	0.792	0.813	0.875	0.236	1.000
	(0.006)	(0.007)	(0.000)	(0.000)	(0.000)	(0.201)	

Note: Prob. Values in parenthesis ()

lnGDP (Economic Growth): The correlation coefficient was -0.398, and the associated p-value was 0.027. This negative correlation suggests that higher economic growth is associated with lower levels of unemployment. lnPOP (Population): The correlation coefficient was 0.363, and the associated p-value is 0.045. This positive correlation indicates that higher population is associated with higher levels of unemployment. That is, both correlations were moderate, and the p-values suggested statistical significance. lnGFCF (Gross Fixed Capital Formation): The correlation coefficient was -0.027, and the associated p-value was 0.006. This weak negative correlation suggests a slight tendency for higher gross fixed capital formation to be associated with lower unemployment. The p-value indicates statistical significance.

Results of Unit Root Tests

Table 4.3 presents the results of the Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) unit root tests. The ADF results indicate that the variables: UNEM, lnGDP, and lnGFCF possess unit roots at their levels. Similarly, the PP unit root tests demonstrate that all variables have unit roots at their levels. Consequently, the null hypothesis was not rejected, indicating that the variables are non-stationary at levels. However, both the ADF and PP tests demonstrate that the unit root disappears after taking the first difference, rendering the variables stationary. This suggests that they are integrated of order one, denoted as I(1). On the other hand, the ADF test indicated that the variables lnGEXE, lnGEXH, and lnPOP do not have unit roots at their levels. Therefore, the null hypothesis can be rejected, implying that these variables are stationary at levels or integrated of order zero, denoted as I(0).

Table 4.3: ADF and PP Unit Root Test Results

Level				Remark	
ADF		PP			
Variables	t-Statistic	Prob.	t-Statistic	Prob.	

lnUNEM	1.031	0.999	1.031	0.999	
lnSMEs	-4.217	0.328	-2.567	0.243	
lnGEXE	-3.355	0.077	-3.147	0.114	I(0)
lnGEXH	-3.247	0.095	-3.034	0.140	I(0)
lnGDP	-0.756	0.817	-0.643	0.846	
INFL	-2.524	0.315	-2.792	0.211	
lnPOP	-3.931	0.025	-1.802	0.679	I(0)
lnGFCF	1.335	1.000	1.491	1.000	
First difference					Remark
lnUNEM	-4.511	0.006	-4.562	0.006	I(1)
lnSMEs	-6.731	0.003	-3.456	0.000	I(1)
lnGEXE	-11.260	0.000	-10.554	0.000	I(1)
lnGEXE	-12.746	0.000	-16.057	0.000	I(1)
lnGDP	-2.701	0.086	-2.680	0.089	I(1)
INFL	-5.363	0.001	-7.941	0.000	(1)
lnPOP	-3.252	0.028	-1.635	0.095	(1)
lnGFCF	-4.122	0.015	-4.182	0.013	I(1)

Note: both intercept and trend were used for the estimations. Akaike Information Criterion (AIC) was employed to select optimum lag length in the ADF test.

Results of ARDL Long-Run and Bounds Test

Having confirmed mixed order stationarity of the variables, ARDL approach for co-integration test was conducted to determine existence of long-run relationship among the variables.

Table 4.4: ARDL Bound Test for Cointegration Results

F- Statistics	K	Significance	Lower(bound)	Upper(bound)
6.490692***	6	10%	2.12	3.23
		5%	2.45	3.61
		1%	3.15	4.43

The decision rules states; if computed F-statistic is greater than the upper bound [I(1)], it implies rejection of the null hypothesis of no co-integration among the variables and conclude that there is co-integration (long-run) relationship among the variables. But, if the computed F-statistic is less than the lower bound [I (0)], the null hypothesis of no co-integration among the variables cannot be rejected. However, the bounds test result indicated that the computed F-statistic was greater than the upper bound at 1% significance level. Thus, there is a co-integration or long run relationship among the variables in the model. Hence, though the short-run relationship among the variables was distorted, the long-run equilibrium was attained.

Results of ARDL Long-run and Short-run Parameters Estimate

This section discussed the results of estimations of long-run and short-run parameters using ARDL model to address the objectives of the study.

Table 4.5: Results of Long and Short run Estimated Coefficients

Panel A: Long-run Coefficients - Dependent variable is LNUNEM

Variables	Coefficient	Std. Error	t-Statistic	Prob.
LNSMES	-0.727485	0.256350	-2.837861	0.0125
LNGEXE	-0.066359	0.033708	-1.968648	0.0678
LNGEXH	-0.052801	0.024796	-2.129408	0.0502
LNGDP	-1.165667	0.561517	-2.075925	0.0555
LNPOP	24.61954	11.16594	2.204878	0.0435
LNGFCF	0.052902	0.128023	0.413219	0.6853

Panel B: Short-run Coefficients - Dependent variable is Δ UNEM

C	-38.60815	4.843983	-7.970332	0.0000
D(LNUNEM(-1))	-0.727485	0.159901	-4.549598	0.0004
D(LNGEXE)	-0.066359	0.012960	-5.120266	0.0001
D(LNGEXH)	-0.032990	0.012082	-2.730564	0.0155
D(LNGDP)	-0.256550	0.137764	-1.862238	0.0823
D(LNPOP)	26.72035	4.543096	5.881529	0.0000
D(LNGFCF)	-0.060058	0.034791	-1.726264	0.1048
ECT _{t-1}	-0.368388	0.046190	-7.975511	0.0000
R-squared	0.850536			
F-statistic	17.07175			0.000
Durbin-Watson stat	2.086957			

Note: Akaike Information Criterion (AIC) was used to select optimum lags of (2,0,1,1,1,1,1).

Source: Author's computation (2023)

In the long-run analysis (i.e. panel A), the impact of SMEs, government education expenditure (LNGEXE) and government health expenditure (LNGEXH) on unemployment rate were examined. For LNSME coefficient (-0.727485) with a p-value (0.0125), indicated that SMEs had a long-run impact on unemployment rate at 5% significance level. The negative coefficient (-0.727485) for LNSMEs suggests that an increase in the number of SMEs by 1% will lead to a decrease in the long-run unemployment rate by 0.73%. For LNGEXE, the coefficient was -0.066359 with a p-value (0.0678) indicating its impact on the long-run unemployment rate at 10% significance level. The negative coefficient (-0.066359) suggested that an increase in government education expenditure by 1% will lead to a decrease in the long-run unemployment rate by 0.07%. For LNGEXH, the coefficient was -0.052801 with a p-value of 0.0502. This indicates that it has impacted on the long-run unemployment rate at 10% significance level. The negative coefficient (-0.052801) suggested that an increase in government health expenditure by 1% may potentially lead to a decrease in the long-run unemployment rate by 0.05%. Similarly, the coefficient for LNGDP was -1.165667

with a p-value of 0.0555. This suggests that LNGDP had a long-run impact on unemployment rate at a 10% significance level. The negative coefficient (-1.165667) implies that a 1% increase in GDP may lead to a decrease in the long-run unemployment rate by 1.17%. The coefficient for LNPOP was 24.61954 with a p-value of 0.0435. This indicates that it has an impact on the long-run unemployment rate at a 5% significance level. The positive coefficient (24.61954) suggests that a 1% increase in population may lead to an increase in the long-run unemployment rate by 24.61%. Furthermore, the coefficient for LNGFCF was -0.060058 with a p-value of 0.6853. The probability value suggests that the coefficient is not statistically significant at the conventional levels of significance. Therefore, there is limited evidence to suggest that LNGFCF has a significant impact on the long-run unemployment rate.

In panel B, which focuses on the short-run coefficients, we can interpret the results using a similar pattern as in the long-run analysis. The coefficient for D(LNSMES) was -0.727485 with a p-value of 0.0004. This suggested that there was some evidence to indicate that changes in SMEs had impacted on the short-run unemployment rate at a 1% significance level. The negative coefficient (-0.727485) implies that an increase in the number of SMEs by 1% may lead to a decrease in the short-run unemployment rate by 0.73%. For D(LNGEXE) the coefficient for is -0.066359 with a p-value of 0.0001. This suggested that there was some evidence to indicate that changes in government education expenditure (D(LNGEXE)) had impacted on the short-run unemployment rate at a 1% significance level. The negative coefficient (-0.066359) implies that an increase in government education expenditure by 1% may lead to a decrease in the short-run unemployment rate by 0.071%. Similarly, the coefficient for D(LNGEXH) is -0.032990 with a probability value of 0. .0155. This indicated that there was an evidence to suggest that changes in government health expenditure (D (LNGEXH)) had a significant impact on the short-run unemployment rate. The p-value suggested that the coefficient was statistically significant at conventional levels. The coefficient for D(LNPOP) was 26.72035 with a p-value of 0.0000. This indicated that there was strong evidence to suggest that changes in GDP (D(LNPOP)) had a significant impact on the short-run unemployment rate at a 1% significance level. The positive coefficient (26.72035) suggests that an increase in population by 1% may lead to a decrease in the short-run unemployment rate by 26.72%. The coefficient for D(LNGFCF) was 0.032 with a p-value of 0.1048. This indicated that there was limited evidence to suggest that

changes in government fixed capital formation ($D(LNGFCF)$) had significant impact on the short-run unemployment rate. The p-value suggested that the coefficient was not statistically significant at conventional levels.

The error correction term (ECT_{t-1})' coefficient was significant at 1% and negative. This matches our assumption. The study showed 36.83% of deviations from equilibrium to be repaired within one year. Together, the independent variables in the models properly explain the changes in unemployment in Nigeria. This was suggested by the high R-square (0.850536). It means that explanatory factors in the model explain 85.05% of the fluctuations in unemployment from 1991 to 2020.

Results of Diagnostic Tests

The outcomes of diagnostic tests suggested that model for ARDL satisfies all. Hence, computed relationship was free from serial correlation, normalcy and heteroscedasticity issues. Furthermore, there was no missing variable biasness.

Table 4.6: Result of Diagnostic Tests

Test Statistics	F-Statistic [prob.]
Normality: Jarque-Bera	0.5299 [0.7673]
Serial Correlation: Breusch-Godfrey LM Test; F (2,13)	0.495 [0.2148]
Heteroskedasticity Test; F (14, 15)	0.3876 [0.3382]
Functional Form: Ramsey Reset; F (1, 19)	2.9667 [0.1043]

Results of Model Stability Tests

The CUSUM) and (CUSUMQ) tests were applied to assess the stability of the estimated parameters. The plots were both within the bounds (see Figure 4.1) indicating that the model is long-term stable.

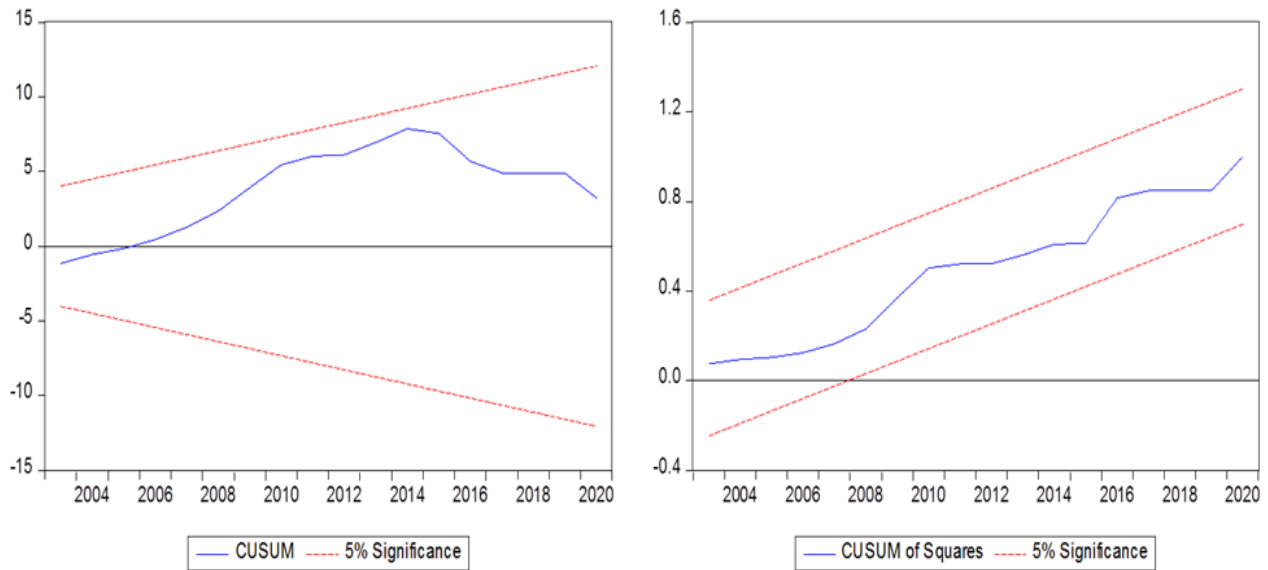


Figure 4.1: CUSUM and CUSUMSQ

Test of Hypotheses

In this study, the validity of long-accepted idea (theory) of the influence of entrepreneurship on unemployment was tested using the number of SMEs, government expenditure on education and health as proxies. We found that the hypotheses were valid in Nigeria. Thus, there was evidence to reject the null hypotheses of the study. The ARDL estimation technique was employed to explore the connectivity between, the independent variables and the dependent variable. The outcome revealed that the number of SMEs, health expenditure and education expenditure had significant impact on unemployment in Nigeria. Therefore, the null hypotheses were rejected.

5) Conclusion

This study examined the relationship between entrepreneurship and unemployment rates. The long-run and short-run significance of government expenditure for both education and health on unemployment rates was established. This suggests that investing in education and health sectors can effectively reduce unemployment over the long term and in the immediate future. The study highlights the importance of government spending on these sectors as a means to foster economic development and create employment opportunities. It underscores the need for policymakers to prioritise investments in these areas to address the issue of unemployment. However, future research should explore additional factors and that may contribute to better understanding of entrepreneurship-unemployment nexus.

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**EFFECT OF KNOWLEDGE SHARING AND INNOVATION ON PERFORMANCE:
A REVIEW OF UNIVERSITY ACADEMIC STAFF**

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ABSTRACT

Innovation, across different industries, is a crucial driver of organizational growth and human capital development. This is of particular relevance in universities, which are saddled with the responsibility of developing human capital for national development. The study examined the relevance of knowledge sharing soft skills and online facilitation, as areas of innovation that can enhance the performance of academic staff in the selected university. The study adopted survey research design using structured questionnaire to gather relevant data from 300 sampled academic staff of the university. Logistic regression was used to analyze the impact of knowledge sharing and innovation on academic staff performance. Results revealed that innovation has significant positive impact on academic staff performance. The study recommended that universities should promote and increase efforts in creating opportunities and more avenues for sharing knowledge-based information using various e-learning platforms.

Key words: Innovation, Knowledge Sharing, ICT Skills, Employee Performance.

Introduction

Employee performance is crucial for every organization since it serves as a metric of a company's success. The company's non-financial variables, including teamwork, motivation, production index, service quality, and competence, are assessed using this method (Suriati et al, 2015). Knowledge is essential for an organization to maintain a sustainable competitive edge. Organizational learning helps firms develop skills and knowledge, allowing them to effectively handle intangible resources for a lasting competitive edge (Afshari & Nasab, 2020). Knowledge sharing is an activity that contributes to knowledge management. Enhanced information sharing enables the distribution, application, and advancement of current knowledge. Lack of systematic knowledge sharing can harm the company as knowledge is solely contained within individuals' minds. Sharing knowledge can inspire an individual to think creatively, effectively, efficiently, and innovatively (Fausiyah, 2020). Innovation mostly involves generating novel ideas to develop products or processes, aiming to enhance effectiveness and efficiency to boost employee performance and corporate

outcomes. This applies to both for-profit and non-profit organizations, including colleges and universities. Today, innovation is a key factor for growth and success in the competitive corporate environment, especially in areas like information technology (IT) (Wankhede et al. 2023). Innovation is considered a crucial aspect that impacts the performance of enterprises. Innovation involves introducing additional processes to create new services or products that meet unmet demands or address previously unresolved issues in the market or society. Human Capital refers to the economic worth derived from an individual's expertise and abilities. In the information-based economy, knowledge has become a significant tangible asset for enterprises and a crucial factor in achieving lasting competitive advantage. Organizing information and fostering innovation are essential for enhancing organizational capability (Afshari & Nasab, 2020).

Literature Review

Knowledge sharing

Organizations are consistently challenged to enhance their performance and maintain flexibility in response to dynamic business contexts (Aina & Atan, 2020). Knowledge sharing, the act of disseminating organizational knowledge among members, is a crucial aspect in helping organizations achieve their goals. Knowledge sharing is the process of transferring information between individuals or entities. Knowledge sharing is a crucial component of the knowledge management process as it facilitates the transfer, generation, and conservation of knowledge and skills inside a company. It offers extensive learning opportunities for all individuals of the organization to enhance their skills autonomously. Sharing knowledge is commonly viewed as a method to enhance communication and cooperation within a team or company (Castaneda & Cuellar, 2020). The organization's most significant asset is the combined knowledge held by all its members. Adetunji, Oladejo, and David (2016) highlighted that sharing information of best practices is crucial for development. Knowledge is imparted regularly, either intentionally or unintentionally. It is the responsibility of colleges to meticulously prepare their graduates to meet the requirements of the broader community. Adetunji, Fadun, and Oyekan (2018) suggested that sharing information can have a good impact on employees and community leaders' views on development, perhaps enhancing human capital development in councils if they see benefits. Hence, it involves not just the sharing of information but also includes certain stimuli.

Information exchange and information sharing are frequently used as synonyms for knowledge sharing. Various methods exist for disseminating knowledge. Knowledge-sharing activities can encompass offering training or tutorials, as well as sharing information through informal chats or printed materials. Knowledge exchange can happen without face-to-face connection, for example through electronic means like email or social media. Chandra's (2016) study replicates the results of Nanjundeswaraswamy and Swamy (2014) by doing a quantitative analysis that connects employee performance, information sharing, and work happiness with effective leadership styles.

Knowledge Management is a corporate ideology. A developing framework consisting of ideas, processes, organizational structures, and technology applications that facilitate individuals in sharing and utilizing their knowledge to achieve business goals. This emphasizes the individual, known as the knowledge worker, and the comprehensive aspect of knowledge management. Primarily, it is essential to satisfy corporate objectives. Information Management is not solely a goal in itself; it is primarily concerned with the sharing and practical use of information. Sharing knowledge is crucial in modern times as the generation and utilization of fresh knowledge are vital for the sustainability of nearly all enterprises. Intangible items such as ideas, processes, and information are increasingly dominating global trade over traditional tangible goods in the manufacturing economy. Continuous innovation is becoming the primary sustainable competitive advantage. In simpler terms, the utilization of recent information.

Innovation

Innovation is a new and beneficial product, service, business model, or strategy. Innovations do not necessarily need to be significant advancements in technology or novel business strategies; they can also include enhancements to a company's customer service or additions to an already existing product (Boyles, 2023). Business innovation can be categorized as either sustaining or disruptive. Sustaining innovation improves an organization's processes and technologies to strengthen its product line for current customers. It is usually undertaken by established businesses who aim to maintain their position at the top of their market. Disruptive innovation occurs when smaller enterprises confront larger businesses. Kim and Lee (2019) studied how innovation affects employee motivation in the IT industry. Innovation has a good impact on employee motivation through offering chances for personal development, autonomy, and demanding tasks. They stressed the significance of creating a

friendly and innovative work environment to boost employee engagement and promote new behaviors.

Employee Performance

Ojokuku and Akanbi (2015) concurred with Gupta (1980) that performance should be defined as the results of work as they are closely connected to the strategic objectives of the organization, customer happiness, and economic contributions. Wang (2010) stated that performance assessment at universities mostly emphasizes output and outcome metrics, neglecting the comprehensive evaluation of the entire academic process from input, through process, to output and outcome. Universities do not prioritize profit maximization like most private sector firms. Universities may aim to sustain a steady operational posture in order to gradually accomplish organizational goals. Therefore, the performance of universities can be assessed by how well each university's functions align with the university's aims.

Theoretical approach to Employees Performance

Two theories that underpins this study are Goal Setting Theory and Learning Curve Theory. While the Goal Setting Theory proposed by Edwin Locke in the year 1968 suggests that the individual goals established by an employee play an important role in motivating him for superior performance, Learning Curve Theory is based on the concept that the more an individual repeats a process or activity, the more adept they become at that activity.

Hayward-Wright (2009) claims that there are two types of approaches to share knowledge in an organization, system-based knowledge sharing (managing documents, contact database, expert database, analysis of social networks and online training program) and people-based knowledge sharing (mentoring, coaching, storytelling, networking, joint decision making, interviews, forum / community-based practice).

Problem Statement

It has been observed that most Nigerian Universities are increasingly becoming top loaded in terms of academic staff strength. There are more Professors and Associate Professors than Graduate Assistants or Assistant Lecturers (Akosile&Olatokun, 2020). Research suggested that about 73% of senior academics are at the top academic cadre while 27% are in the junior academic cadre. Previous studies, Akosile&Olatokun, (2020), also revealed that knowledge sharing can be one of the leading factors that are responsible for rapid academic staff performance. The study analyzed the effect of knowledge sharing and innovation on academic staff performance in a selected university in Nigeria.

Hypotheses

H1o: knowledge sharing has no significant effect on academic staff performance.

H1: knowledge sharing has significant effect on academic staff performance.

H2o: innovation has no relationship with academic staff performance.

H2: innovation has significant relationship with academic staff performance.

Methods and Procedures

The research is quantitative and utilizes purposive sampling to collect pertinent information from respondents, specifically the academic staff of Ladoke Akintola University of Technology (LAUTECH), Ogbomoso. LAUTECH was selected for being the top State-owned university in Nigeria based on the 2023 Webometric Ranking. The study relies on data gathered from a primary source. In January 2024, a survey of 300 academic staff was performed to gather their opinions on the correlation between knowledge sharing, innovation, and academic staff success. A closed-ended questionnaire was created utilizing a five-point Likert scale to assess information sharing activities and constraints on innovation affecting employee performance. A pilot research was conducted to gather the views of 15 academic staff members who are expertise in management and leadership roles within the faculty. A digital questionnaire based on a Google survey form was created for delivery to participants. A research questionnaire was delivered to academic personnel in several university faculties through both physical and online surveys. The survey data was evaluated using several statistical tools to understand the relationship between information sharing, innovation, academic staff performance, and the use of new instructional tools. A logistic regression analysis was conducted to assess the influence of the independent variables, information sharing and innovation, on academic staff performance.

Results and Discussion

Analysis of data illustrates an equal percentage of 50% respondents for both male and female academic staff who took part in the survey (See Figure 1).

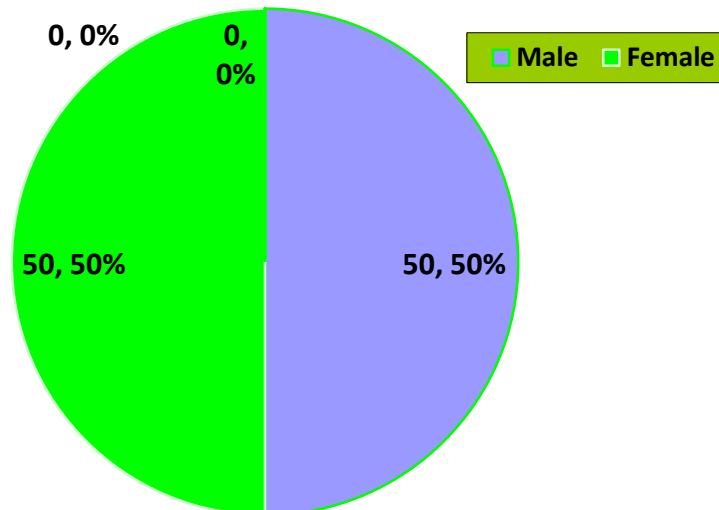


Figure 1: Proportion of Respondents - Academic staff

Source: Data analysis (2024)

Independent t – test

Independent t - test is a statistical tool to compare means of two different populations. Study attempts to verify reliability of responses respective to knowledge sharing and innovation activities variation. Independent t – test analysis showed that male respondents has standard deviation near to that of female academic staff as shown in the table 1. Although many studies and organizational policy has raised concern for equal opportunity between male and female at work as an important aspect of gender balancing, however the study find itself in an accidental match. This match shows fairness in the distribution of questionnaire to respondents. This study joined earlier studies to establish that equal employment opportunity has a significant mechanism to knowledge sharing and innovation activities that enhance academic staff performance of both senior or junior staff. This also have a positive impact on level of knowledge sharing activities and its integration of innovation which in turn enhanced the academic staff ability to share.

Table - 1

Group Statistics of academic staff performance to knowledge sharing and innovative activities

Academic staff Respondent	N	Mean	Std.	Std. Error Mean

			Deviation	
Male	150	0.693	0.463	0.038
Female	150	0.767	0.424	0.035

Source: Data analysis (2024)

The t-test for equality of means has depicted there is no effect of variation in knowledge sharing and innovative activities of academic staff performance (See Table - 2). This study found that certain activities contribute to the staff's ability to share. Each activity was examined individually and yielded comparable results. The activities evaluated include mentoring, experiential learning, documentation, online training, and job coaching to facilitate knowledge transfer between senior and junior academic personnel. Mentoring and experiential learning are widely utilized inside the university system because to the cadre gap. Knowledge sharing and innovation activities are not influenced by the gender of the respondents. Academic personnel exhibit a similar attitude and behavior towards sharing responsibility. The test results indicate that the p-value assuming equal variances is greater than 0.05. The author did not reject the null hypothesis. Analysis results show no correlation between information sharing, creative activities variance, and Academic staff performance. Both males and females contribute equally to information exchange and using innovative technologies in their teaching methods.

Table-2: Independent samples test for academic staff performance

	Levene's test for equality of variances		t-test for Equality of Means					
	F	Sig.	t	Dt	Sig. (2- tailed)	Mean differe nce	Std. Error Difference	95% Confidence interval of the Difference

								Lower	upper
Equal Variances assumed	8.204	0.004	-1.431	298	0.154	-0.073	0.051	-0.174	0.028
Equal Variances not assumed			-1.431	295.804	0.154	-0.073	0.051	-0.174	0.028

Source: Data analysis (2024)

The research analyzed reveals that the participants' responses on lack of understanding of the knowledge sharing concepts in terms of workload, lack of creativity and relationship are constraint to knowledge sharing and willingness to innovate among academic staff. 43% of the respondent agreed that lack of understanding of the knowledge sharing concepts in terms of workload, lack of creativity and relationship are constraint to knowledge sharing and innovation (See Figure - 2).

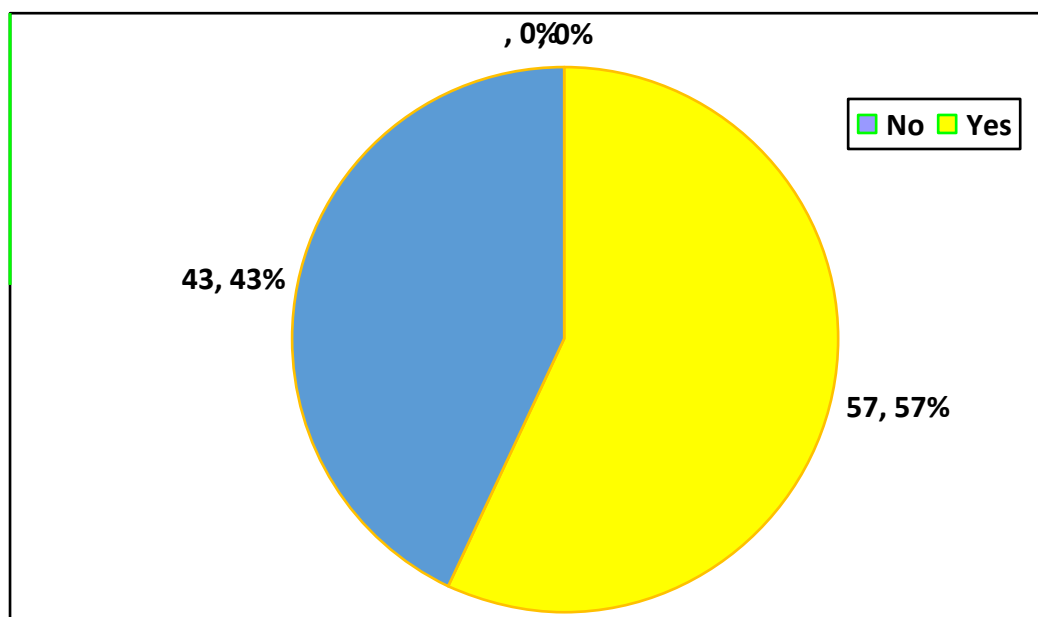


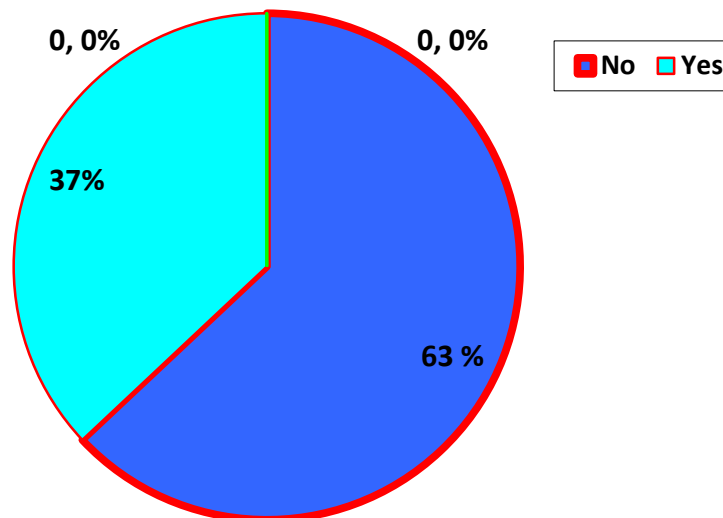
Figure - 2

Source: Data analysis (2024)

Knowledge sharing and innovation activities rely on successful knowledge sharing, aiding personal development, career advancement, and the generation of new ideas. 57% of respondents believe that network connectivity issues, inconsistent power supply, and knowledge hoarding operate as barriers that hinder the promotion of knowledge sharing and collaborative activities among academic personnel. The research indicates that without a structured system for coordinating information exchange and innovation activities alongside university operations, there is a risk that a lack of cooperation among academic staff will persist as an issue. 43% of participants indicated that engaging in knowledge sharing activities such as experiential learning, job coaching, and discussion forums during workshops and documentation had boosted their participation in information sharing.

The respondents believed that engaging in knowledge sharing through practical experience and on-the-job training positively impacts the creation of extensive learning opportunities. Workshops and documentation promote teamwork, facilitating the achievement of objectives. The respondents agreed that information sharing fosters innovation, but they also expressed concerns about the risk of ideas being stolen or manipulated. This contrasts with the literature by Adetunji, Fadun, and Oyekan (2018), which defines knowledge sharing as the exchange of information between individuals or organizations. They suggest that information sharing is influenced by elements such as rewards and benefits as a primary motivator. Gupta (1980) was backed by Ojokuku and Akanbi (2015) who said that performance should be defined as the results of work as they are closely connected to the strategic objectives of the organization, customer happiness, and economic impact.

Analysis of the relationship between knowledge sharing, innovation activities, and academic staff performance showed that only 37% of respondents believed that the activities mentioned in the questionnaire are effective for fostering innovation and generating new ideas for product or process implementation (Refer to Figure - 3). The research indicated that information exchange and innovation activities consistently have a favorable effect on university academic staff. Establishing and executing procedures for exchanging knowledge can enhance the performance of academic personnel in several ways.

**Figure – 3**

Source: Data analysis (2024)

Chi-Square Tests

Chi-square is used to measure association between variables. Study has conducted chi-square analysis to verify association between knowledge sharing and innovation activities on academic staff performance.

Analysis of chi-square showed a significant association between independent variable academic staff performance and dependent variable knowledge sharing and innovation activities (See Table - 3). The p-value of chi-square test is less than 0.05. Therefore, the null hypothesis rejected, that is, no association between knowledge sharing activities and innovation activities, this implies that blended learning shares no significant with need to share knowledge.

Table – 3: Chi-Square Tests for association between knowledge sharing activities and innovation activities

	df	Asymptotic Significance (2-sided)

Pearson Chi-Square	1	0.001
Continuity Correction	1	0.001
Likelihood Ratio	1	0.001
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 34.83. b. Computed only for a 2x2 table		

Source: Data analysis (2024)

Logistic Regression Analysis Model Summary

Binary logistic regression is effective tool to calculate the effect of independent variable (knowledge sharing and innovation activities) on dependent variable (academic staff performance). The study conducted the logistic regression analysis to examine effect of knowledge sharing and innovation activities on academic staff performance. The model explains that knowledge sharing caused variation of 3.9% in the university performance (See Table - 4). Model summary depicts that there are other variable which are also responsible for university performance.

Table - 4

Logistic regression model summary for analysis of knowledge sharing and innovation activities on academic staff performance

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	338.053a	0.039	0.056
a Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.			

Source: Data analysis (2024)

Analysis of Variable in Equation

Logistic regression analysis showed a positive relationship between knowledge sharing activities and innovation on academic staff performance. The p-value for test is less than 0.05 that indicated relationship between variable is statistically significant. The research has rejected null hypothesis based on result.

Regression analysis of variable showed knowledge sharing activities has impact of 2.5 times on academic staff performance (See Table - 5). As university implements knowledge sharing and innovation activities in an effective manner, the higher the academic staff performance by 2.5 times.

Studies of Odhiambo, Njanja and Zakayo (2014) concludes that knowledge sharing and innovation activities affects positively the process of stimulating, creating a broad learning opportunities and creativity.

Table – 5: Logistic Regression variables in the equation for analysis of knowledge sharing activities on academic's staff performance

	B	S.E.	Wald	df	Sig.	Exp(B)
knowledge sharing activities (1)	0.907	0.266	11.644	1	0.001	2.50
Constant	0.523	0.182	8.252	1	0.004	1.688
a Variable(s) entered on step 1: knowledge sharing activities						

Source: Data analysis (2024)

Conclusion

The study concluded that innovation and knowledge sharing positively impact the effectiveness of university academic staff. Universities should enhance efforts to create chances for sharing knowledge through e-learning platforms. Individuals should recognize that sharing knowledge is beneficial for their own personal gain. The previous belief that

"knowledge is power" should now be replaced with the understanding that "sharing knowledge is power". When individuals recognize that sharing their knowledge enhances job performance, job security, personal growth, career advancement, productivity rewards, and personal recognition, knowledge sharing will be actualized.

Recommendation

The study recommended that universities should promote and increase efforts in creating opportunities and more avenues for sharing knowledge-based information using various e-learning platforms. Furthermore, academic staff should be encouraged and motivated to cooperate with one another to make knowledge sharing work thereby improve on their performance.

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THE IMPACT OF HUMAN BEHAVIOUR ON PROJECT DELIVERY SUCCESS IN SPACERESEARCH AND DEVELOPMENT PROJECTS

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ABSTRACT

Space research and development (R&D) projects are critical for technological progress but face unique project management challenges. This study examined the impact of human behavioural factors on project delivery success in the Nigerian space R&D initiatives. A survey of 294 project managers and specialists in the space sector analysed relationships between communication, incentives, trust, change management and project outcomes of schedule and budget adherence. Correlation analysis revealed significant negative correlations between these human factors and project overruns. Breakdowns in communication, insufficient incentives, lack of trust, and poor change management had robust linkages with schedule delays and cost escalations. The results highlight that human dynamics cannot be discounted in favour of technical factors alone when managing complex space projects. To ensure project success, organizations must elevate the priority of people-focused practices on par with technical elements. Proactively developing communication channels, trust, incentives and change readiness across teams and stakeholders can mitigate risks of overruns. This study contributes valuable empirical evidence regarding the pivotal role human collaboration and culture play in space project delivery in the Nigerian context.

Keywords: Human Behaviour, Project Success, Project Management, Space Research and Development, Communication, Correlation

1.0 Introduction

Space research and development (R&D) projects are emerging as critical drivers of technological advancement and economic growth (Asiyanbola *et al.*, 2021). These projects, which encompass satellite development, space exploration, and applications such as remote sensing and communication, present unique challenges and opportunities for the country. While much attention is rightfully given to the technical aspects of these projects, the role of human behaviour in their success is often overlooked. Human behaviour, including communication, motivation, teamwork, and leadership, plays a crucial role in the success of in all sectors (Opoku *et al.*, 2024). Effective communication is essential for coordinating efforts among stakeholders and ensuring that project goals are clearly understood (Safapour *et al.*, 2021). Motivation and teamwork are vital for maintaining high levels of performance and commitment among project team members (Adu and Opawole, 2020). Leadership is crucial for providing direction and guidance to the team, especially in the face of challenges and uncertainties (Zada *et al.*, 2023). The literature on human behaviour in project management and its impact on project delivery success is vast and multifaceted, encompassing various theories, models, and empirical studies.

One of the foundational theories in this area is the human relations approach, which emphasizes the importance of human needs, motivations, and interpersonal relationships in organizational settings (Muldoon *et al.* 2020). This approach laid the groundwork for understanding how human factors influence project outcomes. Subsequent research has built upon this foundation, highlighting specific aspects of human behaviour that are particularly relevant to project management. For example, the concept of emotional intelligence has gained prominence in recent years as a key determinant of effective leadership and team dynamics (Kukah *et al.* 2022). Emotional intelligence encompasses the ability to understand and manage emotions, both in oneself and others, and has been shown to positively impact project performance (Montenegro *et al.*, 2021; El khatib *et al.*, 2021). Other studies have focused on the role of trust in project management, highlighting its importance in building effective relationships and facilitating collaboration among project stakeholders (Shaukat *et al.*, 2022; Barraneet *et al.*, 2021). Trust is particularly crucial in complex projects such as those in the space sector, where multiple stakeholders with diverse interests and backgrounds must work together towards a common goal. Motivation theories, such as expectancy theory (Vroom, 1964) and goal-setting theory (Locke & Latham, 1990), have also been instrumental in understanding how to motivate individuals and teams in project settings (Gould, 2024). These theories suggest that setting clear goals, providing appropriate incentives, and ensuring that individuals believe their efforts will lead to desired outcomes are essential for motivating team members and achieving project success. Despite the importance of human behaviour, there is a lack of research on how these factors impact the success of space projects in Nigeria. This gap in knowledge limits our understanding of the challenges faced by project managers and the strategies needed to overcome them. By addressing this gap, we can improve the effectiveness of space R&D projects in Nigeria and enhance their contribution to national development. This paper aims to examine the impact of human behaviour on project delivery success in Nigeria's space sector. Drawing on a quantitative study conducted among Nigerian space R&D project managers, the paper seeks to identify the key human factors that influence project outcomes and provide recommendations for enhancing project performance. By doing so, this paper contributes to the growing body of knowledge on space research and development in Nigeria and informs future efforts in this critical area.

2.0 Methodology

This study employed a random sampling technique to select participants from the population of Nigerian space R&D project managers. The Cochran formula was used to determine the sample size: $n_0 = \frac{Z^2 p q e^2}{e^2}$

Where e = precision level (i.e., the margin of error),

p = the proportion of the population which has the attribute in question,

$q = 1 - p$.

Thus $n_0 = \frac{1.96^2 (0.5 \times 0.5)}{0.05^2}$

$n_0 = 384$

A survey questionnaire was used as the primary data collection instrument, comprising multiple choice and Likert scale questions. The questionnaire aimed to gather information on human factors such as communication, motivation, teamwork, and leadership, and their impact on project outcomes such as schedule and budget adherence. Data collected from the survey were analysed using correlation analysis to examine the relationships between human factors and project outcomes. Pearson correlation coefficients (r) were calculated using statistical software (IBM SPSS) to determine the strength and direction of these relationships. Ethical considerations were taken into account throughout the research process. Participation in the survey was voluntary, and informed consent was obtained from all participants. Confidentiality and anonymity of responses were maintained, and the data collected were used solely for research purposes.

3.0 Results

3.1 Background Data of respondents

Out of 384 Nigerian space R&D project managers invited to participate in the survey, 294 completed the survey, providing valuable insights into their roles, experience, and organizational affiliations within Nigeria's space sector. Table 1 presents the demographic characteristics of the respondents:

Table 1: Background Data of Respondents

Profile Frequency Percentage (%)

Role in Space Projects

Project Manager 115 39.1

Technical Specialist 77 26.2

Researcher 61 20.7

Administrator 41 13.9

Years of Experience

Less than 5 years 69 23.5%

5 to 10 years 92 31.3%

More than 10 years 133 45.2%

Organization Affiliation

Government Agency 154 52.4%

Private Company 92 31.3%

Academic Institution 48 16.3%

The majority of respondents were project managers (39.1%), with significant representation from technical specialists (26.2%) and researchers (20.7%). Regarding experience, a substantial portion of respondents had more than 10 years of experience (45.2%), indicating a wealth of knowledge and expertise within the field. Government agencies were the most common organizational affiliation among respondents (52.4%), followed by private companies (31.3%) and academic institutions (16.3%).

3.2 Correlation Analysis

Correlation analysis was conducted to explore the relationships between human factors (communication, motivation, teamwork, and leadership) and project outcomes (schedule adherence and budget adherence). Table 2 summarizes the correlation coefficients and their significance levels:

Table 2: Correlation Analysis

Human Factor Schedule Adherence (r) Budget Adherence (r)

Communication -0.62** -0.58**

Incentives -0.52** -0.50**

Trust -0.55** -0.50**

Change Management -0.58** -0.56**

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

The results indicate significant negative correlations between all human factors (communication, incentives, trust, and Change Management) and both project outcomes (schedule adherence and budget adherence). Higher levels of communication, motivation,

teamwork, and leadership were associated with lower instances of schedule and budget deviations, highlighting the importance of these human factors in project delivery success.

4.0 Discussion

4.1 Communication

Effective communication was found to be critical for project success, with the analysis showing a strong negative correlation ($r = -0.62/-0.58$) between communication breakdowns and schedule/budget overruns. This aligns with past literature emphasizing communication as a fundamental enabler of project delivery (Jawad and Ledwith, 2021; Cheung *et al.*, 2013). Several aspects of communication appear to be particularly impactful. Transparency around project status, risks, and changes is key for proactive planning and mitigation. Regular feedback channels through status reports, meetings, and informal check-ins help surface issues early before escalation. Information sharing between team members ensures availability of critical knowledge and context for collaborative problem-solving. Communication lapses negatively affect coordination across teams, partners, and stakeholders (Safapour *et al.*, 2021). Misalignments arise when changes, risks, and dependencies are not proactively conveyed. Expectation gaps also emerge more easily. Such issues then propagate through the project lifecycle, resulting in significant overruns by the time problems are recognized. Proactive communication strategies are therefore essential from project leadership. Investment in communication practices and norms must be elevated as a priority for organizations. Platforms for transparency, seamless information sharing, and open feedback should be implemented. Leaders should role model strong communication and invite participation at all levels. With mindful planning, communicating through complex space R&D projects can enable success.

4.2 Incentives

The analysis showed a moderate negative correlation ($r = -0.52/-0.50$) between incentives and project overruns. This demonstrates that incentives are an important factor driving team engagement, motivation and performance in space R&D initiatives (Kim, 2022). Incentives serve both intrinsic and extrinsic motivational purposes. Extrinsically, monetary bonuses, promotions, and other rewards connected to project outcomes provide a tangible reason for teams to focus their efforts. Intrinsically, recognition and appreciation for contributions satisfies inherent needs for competence, belonging, and esteem. Inadequate

incentives can lead to reduced morale, lack of ownership, and diminished effort over the project lifecycle (He, 2023). Team members who do not feel appropriately valued and rewarded for their work are less likely to proactively apply their full talents. The resulting lagging engagement and productivity ultimately translates to schedule delays and cost escalations. Project leaders should thus devote attention to developing well-designed incentives targeted to what motivates their teams. Regular reinforcement of incentives and transparent communication of reward criteria helps maintain engagement. Strong incentives enable teams to feel purposeful, energized and committed to project delivery targets.

4.3 Trust

The analysis showed a moderate negative correlation ($r = -0.55/-0.50$) between Trust and project overruns. This highlights the importance of interpersonal trust for achieving project success. Trust between team members, partners, and project leadership enables open sharing of information, collaborative problem-solving, and psychological safety to take risks (Dusenberry and Robinson, 2020). In low trust environments, people hesitate to transparently admit mistakes, raise issues early, and contribute ideas. Distrust manifests through micro management rather than empowerment of teams (Ryan and Cross, 2024). Suspicion replaces assumption of positive intent. Defensive communication diminishes constructive debate of problems. These dynamics constrain innovation, create hidden risks, and ultimately limit performance. Project leaders must actively cultivate trust by role modelling vulnerability, integrity, and respect in relationships. Demonstrating care for team members' growth builds trust. Concrete artifacts like team charters codifying shared values and group norms also enhance trust. Initiatives to connect people inter personally strengthen bonds. Proactively developing high trust teams, partners, and stakeholders enables the open dialogue and courage required for successful complex space projects. This study reinforces trust as a foundational element that cannot be overlooked.

4.4 Change Management

The analysis revealed a moderate negative correlation ($r = -0.58/-0.56$) between change management and project overruns. These highlights change management maturity as an influential factor in project success (Errida and Lotfi, 2021). Organizational changes are inevitable over complex, long-term space R&D initiatives. Advances in technologies, budget adjustments, staffing changes, and other events all require adaptation. Proactively managing

these changes through stakeholder engagement helps ensure successful adoption and minimal disruption. However, when changes are imposed without transparency and participation, resistance emerges (Edwards *et al.*, 2020). Teams become confused, anxious or frustrated by unclear transformations dictated in a topdown manner. The resulting lag in adoption, morale issues, and coordination gaps propagated downstream to negatively impact budget and schedules. Effective change management requires early involvement of those impacted to understand needs. customized support helps team transition through training, communication, and transition planning (Errida and Lotfi, 2021). Leadership alignment and role modelling of changes is vital. Recognizing those who embrace change inspires others.

5.0 Conclusions

This study demonstrated significant negative correlations between human factors and project performance in space research and development initiatives. Communication breakdowns, insufficient incentives, lack of trust, and poor change management had robust linkages with schedule delays and cost overruns. These results provide compelling evidence that human dynamics cannot be discounted in favour of technical factors alone. Managing relationships, alignment, motivation and engagement proactively is indispensable for project success. Organizations undertaking complex space R&D projects must elevate priority of human considerations to match technical elements. Resources should be dedicated to fostering communication, trust, incentives, and change readiness. Leadership training and organizational initiatives focused on these areas can help mitigate risks. By underscoring the pivotal role human factors play in project delivery, this research aims to spur culture change in the space sector. No longer can technology be privileged while culture, relationships and people management are under-resourced afterthoughts. Integrating human-centric practices with technical expertise is imperative. Further studies should continue investigating how to optimize human collaboration, productivity and adaptability within space programs. However, the key message is clear - only by embracing the human dimension with as much fervour as the technical can space organizations achieve the remarkable outcomes that define their missions. The human factors make all the difference between success and failure.

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THE IMPACT OF COURSE SELECTION ON POLYTECHNIC GRADUATES' ENTREPRENEURIAL PATHS (CASE STUDY OF KADUNA STATE)

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ABSTRACT

The purpose of this study is to look into the relationship between the course of study pursued by polytechnic students and their employment preferences. The research aims to test the null hypothesis that there is no significant relationship between the course of study and employment preferences. The Hypothesis was tested using Chi-Square data, which demonstrates a highly significant relationship between program of study pursued by polytechnic students and their employment preferences. It has typically highlighted how students have an entrepreneurial mindset and a tendency to explore self-employment as a career option after graduation. The study concludes that students have an entrepreneurial attitude and suggests that Nigerian polytechnics develop an entrepreneurial culture by imparting entrepreneurial tendencies and assisting students in pursuing autonomous projects. The government might also provide financial assistance to graduates who want to start their own firms.

Key Words: Entrepreneurship, Courses and Graduates

Introduction

Entrepreneurship has become a prominent subject of academic research, capturing the attention of scholars, academicians, and policymakers worldwide. Various definitions and perspectives exist regarding entrepreneurship, but most studies emphasize the significance of risk-taking, innovation, and the identification and exploitation of opportunities. Entrepreneurship is considered a pathway to achieve rapid economic development and address issues such as unemployment, poverty, and underdevelopment, particularly in developing nations. Naude (2011) identifies three factors that have increased the importance of entrepreneurship: the rise of an entrepreneurial economy, the creative entrepreneurial revolution, and a shift in focus by donor organizations towards private sector development in the least developed countries.

Nigeria has implemented numerous policies and programs in the past three decades to promote entrepreneurship. However, the country continues to face high unemployment rates, with over 100 million Nigerians living on less than \$1 per day. Despite the widespread belief that entrepreneurship development is crucial for poverty alleviation, job creation, and rapid economic growth, Nigeria's unemployment rate rose from 13.1% in 2000 to 23.9% in 2011,

with youth unemployment estimated to be over 50%. Furthermore, in 2010, over 60.9% of the population lived in extreme poverty (IMF, 2013; Risenetworks, 2013). These indicators highlight the pressing need for entrepreneurship development to stimulate economic growth and generate employment opportunities in Nigeria, considering the country's low human development index of 0.453 (UNDP, 2006).

Schumpeter (1934, 1942) conceptualizes entrepreneurship as the role of risk-taking innovators in facilitating rapid economic development through "creative destruction," which involves replacing outdated technologies and ideas with new ones. According to Joseph Schumpeter, the implementation of new combinations can manifest in various forms, such as introducing a new product, adopting a novel mode of production, entering a new market, or restructuring an existing firm to adapt to evolving technologies. While Gartner (1988) defines entrepreneurship as the creation of new organizations, Leibenstein (1968) emphasizes the activities required to initiate or sustain an enterprise. Martin and Osberg (2007) propose three factors that contribute to entrepreneurship: the environment where opportunities arise or are created, the set of personal competencies needed to recognize and seize opportunities, and the ability to realize opportunities by transforming them into viable businesses.

Baron and Henry (2010) highlight that entrepreneurs not only identify possibilities but also create them, thereby generating opportunities that did not previously exist. Shane and Venkataraman (2000) argue that the essence of entrepreneurship lies in the identification, nature, and pursuit of opportunities. However, for Nigeria to maximize the benefits of entrepreneurship, the government must implement policies and programs that encourage entrepreneurial activity and support its growth. Such initiatives should address the challenges hindering entrepreneurship growth, including issues related to infrastructure, access to finance, education, and training.

Given the growing interest in entrepreneurship as an academic field with diverse definitions and perspectives and the persistent challenges faced by Nigeria in achieving economic growth and reducing poverty, it is crucial to explore the relationship between entrepreneurship education and the preferences and outcomes of polytechnic students regarding employment. This research aims to investigate the impact of the program of study pursued by polytechnic students on their employment preferences and shed light on the factors influencing their career pathways. By understanding this relationship, policymakers

and educators can develop targeted strategies to foster entrepreneurship and support the career aspirations of polytechnic students in Nigeria.

Aim and Objectives:

The aim of this research is to explore the relationship between the course of study pursued by polytechnic students and their employment preferences. The objectives of the study are as follows:

1. Examine the career aspirations and preferences of polytechnic students in Nigeria, specifically in Kaduna State.
2. Test the null hypothesis that there is no significant relationship between the course of study and employment preferences among polytechnic students.
3. Investigate the association between the course of study and students' inclination towards entrepreneurship or wage employment.

Research Question:

The main research question addressed in this journal is: "Is there a significant relationship between the course of study pursued by polytechnic students and their employment preferences?"

Subsidiary research questions include:

1. What are the career aspirations and preferences of polytechnic students in Nigeria, particularly in Kaduna State?
2. Does the course of study influence students' inclination towards entrepreneurship or wage employment?
3. How do students' course choices and employment preferences align with their entrepreneurial aspirations?

Hypothesis:

Null Hypothesis: There is no significant relationship between program of study pursued by polytechnic students and their employment preferences.

REVIEW OF RELATED LITERATURE:

By reviewing the related literature, the researchers were able to establish a strong foundation for their study. This enabled them to build upon existing knowledge and theories, identifying key concepts, methodologies, and best practices. Additionally, the insights gained from this literature review helped the researchers develop appropriate research questions and hypotheses, ensuring a focused and purposeful study. Ultimately, the systematic review of related literature played a vital role in shaping the direction and methodology of the research, enhancing its credibility, and contributing to the overall advancement of knowledge in the field.

Conceptual Framework

Additionally, the conceptual framework includes the concept of entrepreneurial learning. This refers to the process of acquiring the knowledge and skills necessary for entrepreneurial success. It can involve various approaches, such as hands-on experiences like running a business as a student or engaging in more formal education, such as entrepreneurship courses. Entrepreneurial learning plays a significant role in equipping individuals with the practical tools and insights needed to thrive as entrepreneurs.

The conceptual framework also recognizes the crucial role played by entrepreneurial support systems, which encompass various resources and networks that aid entrepreneurs on their path to success. These support systems encompass mentorship programs, business incubators, and funding sources, among others. Leveraging these systems provides aspiring entrepreneurs with valuable guidance, expertise, and financial backing, greatly increasing their chances of establishing and growing successful ventures. By comprehending these key elements within the conceptual framework, researchers and educators gain a deeper understanding of how entrepreneurship education can effectively cultivate entrepreneurial skills and knowledge in students. This comprehension serves as a foundation for designing and implementing educational programs and initiatives that aim to foster entrepreneurship and nurture the next generation of innovative business leaders.

Concept of Entrepreneurship Education

Entrepreneurship education can be implemented at different educational levels, ranging from primary and secondary schools to post-secondary institutions such as universities and polytechnics. Additionally, non-traditional education programs, such as online courses and

workshops, also contribute to the dissemination of entrepreneurship education. The flexible nature of these programs allows individuals from diverse backgrounds and circumstances to access entrepreneurial training and develop the skills necessary for success in business ventures. Ultimately, the concept of entrepreneurship education centers around empowering individuals to acquire the knowledge, skills, and mindset required to thrive as entrepreneurs and create their own ventures, contributing to economic growth and innovation.

Theoretical Framework

The study highlights that the success of entrepreneurship education within the polytechnic depends on the establishment of strong support systems and effective networking opportunities. These systems can include mentorship programs, business incubators, access to funding sources, and partnerships with local businesses and industry experts. By providing students with the necessary guidance, resources, and connections, the polytechnic can foster an entrepreneurial ecosystem that empowers students to translate their ideas into viable businesses. Ultimately, this study reinforces the significance of institutional commitment to entrepreneurship education and the development of robust support systems and networks to ensure the success of entrepreneurial initiatives within the polytechnic.

Review of Related Empirical Studies

Education plays a crucial role in a nation's development efforts, with the growth of the education sector serving as a prerequisite for the development of other sectors (Barnabas and Durkwa, 2007). Education is considered a process of cultural development and is believed to liberate people's thoughts and improve their social status (Sule, 2004). By providing individuals with knowledge and skills to enhance their performance, income, and wealth, education and training enable them to empower themselves and escape poverty (Aliu, 2007). Governments and international organizations are actively working to strengthen the education sector in both developed and developing countries, considering the aforementioned circumstances.

Entrepreneurship education has gained significant attention and recognition in curriculum development, with a focus on various methods such as students starting their own businesses, creating formal business plans, and conducting feasibility studies (Vincett and Farlow, 2008; Dickson, Solomon, and Weaver, 2008). The skills associated with entrepreneurship include independence, confidence, youth empowerment, and poverty alleviation (Akpomi, 2009). The

educational system, even in wealthier countries, emphasizes inquiry and the application of discovery in the classroom (Adejimola and Olufunmilayo, 2009).

The human capital or resource space is considered the most effective educational environment for nurturing individuals with an independent, creative, and highly productive mindset, ready to succeed in the twenty-first-century workplace (Aliu, 2007). The government's role in setting an example and fostering an environment that encourages entrepreneurship and technological advancements is crucial for Nigeria's economic growth (McConnell and Brue, 2002; Sagagi, 2007).

Entrepreneurship education emerged in Nigeria as a response to the unemployment challenges faced by young graduates, aiming to equip tertiary students with entrepreneurial competences and skills prior to graduation, enabling them to contribute to individual and national economic development (Oriazowanlan, 2013). It is a relatively new field that has rapidly gained prominence, and it is now recognized as an essential tool for economic growth and development. Entrepreneurship education focuses on teaching individuals the concepts and skills necessary to identify business opportunities and act upon them, emphasizing business imagination, creativity, and risk-taking. Its goal is to prepare students for a successful work life and self-reliance (Buba et al., 2015).

To implement entrepreneurship education effectively, the National Board for Technical Education (NBTE) in Nigeria developed curricula and training manuals for polytechnics and similar institutions. The courses, such as Introduction to Entrepreneurship, Practice of Entrepreneurship, and Entrepreneurship Development, are designed to be both theoretical and practical (NBTE, 2007). The success of the program relies on the competence and preparedness of lecturers, as well as the use of appropriate teaching approaches. The delivery of entrepreneurship education requires effective instructional methodologies to ensure students' knowledge acquisition, retention, assimilation, recall, and application (Ezenwaf and Ndinechi, 2004). The teaching style employed by lecturers directly impacts students' performance.

REASERCH METHODOLOGY

The section further delves into the practical considerations associated with data collection and measurement. It elaborates on the selection of appropriate data sources and explains the rationale behind the chosen sample size and sampling frame attributes. The sampling strategy

employed to ensure the representativeness of the sample is also discussed. Furthermore, the section sheds light on the equipment used for data collection, the design of the questionnaire utilized to gather information, and the methodologies employed to measure and analyze the collected data, ensuring rigor and reliability in the research findings.

RESEARCH DESIGN

In order to decrease the likelihood of personal bias and avoid relying solely on one method or response from one institution, a multi-method approach was used for this study. The objectivity of the research is enhanced by this method. It was necessary to combine primary survey-based data with secondary data from institutional records for the study's approach. The applications for both qualitative and quantitative data were numerous. A select sample of graduates from the chosen colleges received a well-written questionnaire. In order to gather different points of view, cross-referenced data, and objective data confirmation, this was done. This is relevant to the ongoing research since we are linking entrepreneurial education to a variable (job creation) that has already been assessed.

Sources of Data

A standard questionnaire was supplied to graduates of the chosen university, and it was then dispersed around the three Metropolitan Authorities in Kaduna State in order to gather information. This source is recognized as reliable and accurate because it serves as the main source for the study and a source of up-to-date data.

Population of the Study

Graduates from the two institutions (polytechnics) in the State make up the target population. The eleven urban Local Government Areas that make up this study are covered by the three metropolitan organizations; Kaduna Capital Authority, Kafanchan Municipal Authority and Zaria Metropolitan Authority—that the Kaduna State Government created in October 2021. Because they have the highest number of polytechnic graduates in the state, these recently founded metropolitan authorities were chosen.

The Kaduna Capital Authority is made up of the four local government areas of Kaduna North, Kaduna South, Igabi, and Chikun and is located in the Kaduna Central Senatorial Zone. Similarly, the Kafanchan Municipal Authority is made up of the Jema'a, Kaura, and ZangonKataf Local Government Areas in the South Senatorial Zone. The municipal

administrations of Zaria, Soba, Sabon Gari, and Giwa comprise the Zaria Metropolitan Authority. In contrast to the first three Local Government Areas, which are located in the North Senatorial Zone, the final LGA is now placed in the Central Senatorial Zone.

Sample Size and Sampling Procedure

The sample frame for this study is made up of Polytechnic Graduate students with ND and HND certificates from the three Kaduna State Metropolitan Authorities—Kaduna Capital Authority, Kafanchan Municipal Authority, and Zaria Metropolitan Authority. A sample size of forty (40) is deemed enough for administering the questionnaire in each program by three Metropolitan Authorities, giving a total of 240 sample size using Stratified Random Sampling techniques. A population size of 600 was used with 5% margin of error. The sample size was determined using this formula $\frac{N}{1+N.e^2}$

Pilot Testing

A pilot study is widely used to evaluate the feasibility of methodologies, processes, questionnaires, and interviews, as well as their interactions in a given setting. A pilot study may also uncover any ethical or practical concerns that could stymie the major investigation (Doody & Doody, 2015). As a result, researchers conduct pilot studies before embarking on a larger study to identify design flaws, improve data collection and analytic techniques, familiarize and train research staff, evaluate recruiting procedures, and collect critical participant burden information (Prescott & Soeken, 1989; Beebe, 2007).

To assess the survey's validity, a pilot study was conducted with responses from a small sample of respondents. Cronbach's alpha was utilized to evaluate the reliability of the acquired data, and any necessary changes or improvements were implemented as a result. It is calculated by averaging the item variances and the inter-item correlation. It is regarded as a cautious assessment of a test's dependability. A common alpha value is 0.7 or higher, but this varies based on the research topic and test goal.

STATISTICAL ANALYSIS PROCEDURE

The data from the study was analyzed using both inferential and descriptive statistics. In contrast to the inferential statistical method, which primarily employs Chi-square analysis with SPSS statistical software version 23, the comparative analysis comprises tabular display, percentages, and comparison. The Chi-square distribution was used to examine whether there

is a significant association between polytechnic students' course of study and their employment preferences.

RESULTS

This section provided the findings of an investigation into the relationship between the course of study pursued by polytechnic students and their employment preferences. A questionnaire was distributed to graduates of the state's two polytechnics in the Kaduna Metropolitan Authorities, which generated the results.

Table 1: Gender for ND Graduates

Metropolitan Authority	Male		Female		Total	Rate of Response (%)
	Frequency	%	Frequency	%		
Kaduna Capital Territory	18	45	22	55	40	100
Zaria Municipal	24	60	16	40	40	100
Kafanchan Municipal	14	35	26	65	40	100
Total	48	40	72	60	120	100

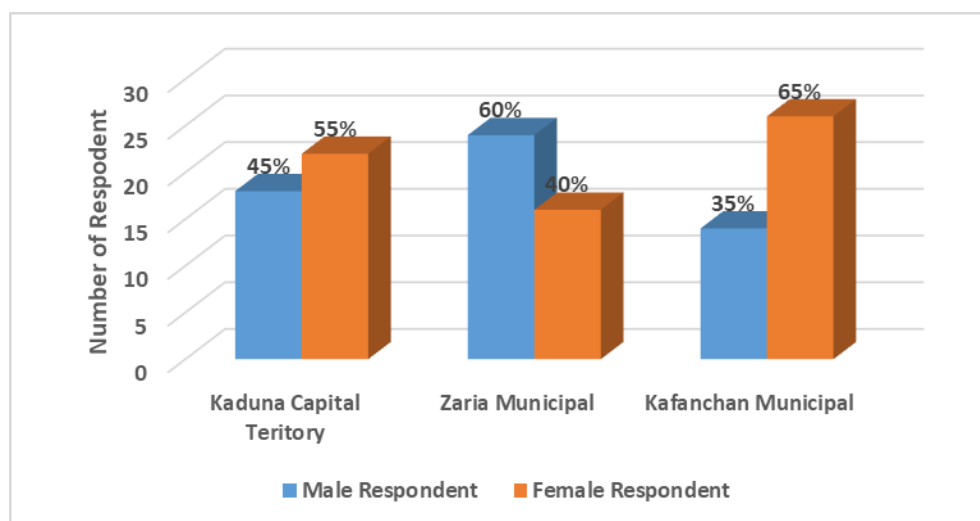
**Figure 1:** Gender for ND Graduates

Table 2: Gender of respondents for HND Graduates

Metropolitan Authority	Male		Female		Total	Rate of Response (%)
	Frequency	%	Frequency	%		
Kaduna Capital Territory	16	40	24	60	40	100
Zaria Municipal	23	57.5	17	42.5	40	100
Kafanchan Municipal	22	55	18	45	40	100
Total	61	50.8	59	49.2	120	100

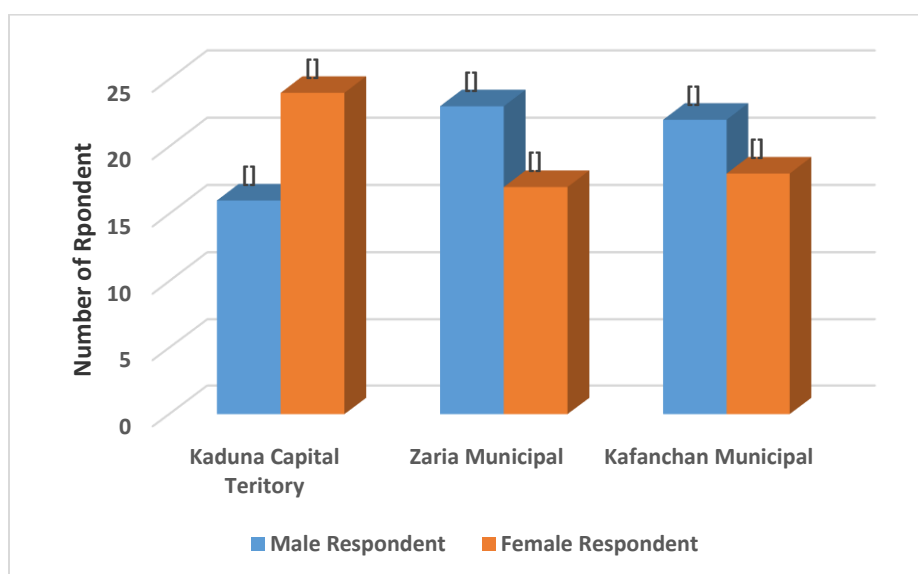
**Figure 2:** Gender for HND Graduates

Table 3: Relationship between course of study & Graduate Employment for National Diploma Students.

Programme of Study /Institution	Self- Employment	Wages Employment	Total
Social Science	30 (75%)	10 (25%)	40
Engineering	32 (80%)	8 (20%)	40
Sciences	19 (47.5%)	21 (52.5%)	40
Total	81 (67.5 %)	39 (32.5 %)	120

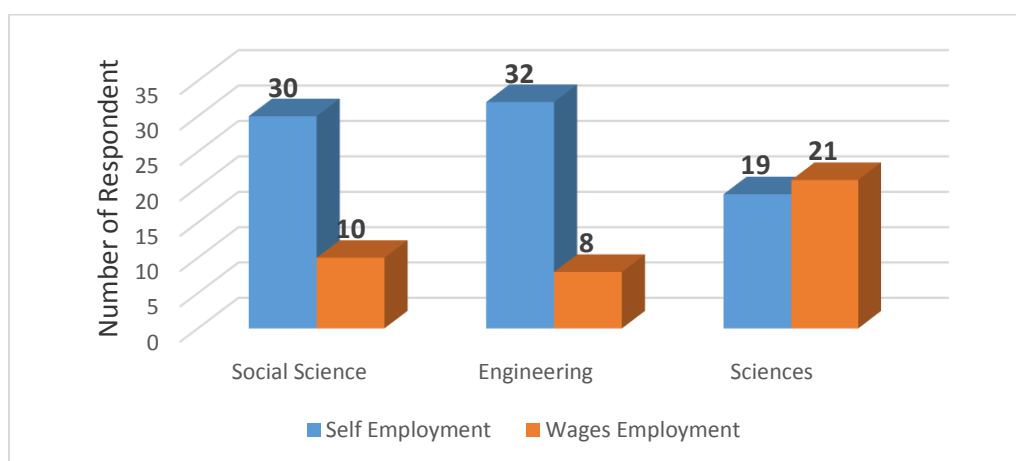


Figure 3: Relationship between course of study & Graduate Employment for National Diploma Students.

Table 4: Relationship between course of study & Graduate Employment for Higher National Diploma Students.

Programme of Study /Institution	Self-Employment	Wages Employment	Total
Social Science	26 (65%)	14 (35%)	40
Engineering	31 (77.5%)	9 (22.5%)	40
Sciences	31 (77.5%)	9 (22.5%)	40
Total	88 (73.3%)	32 (26.7%)	120

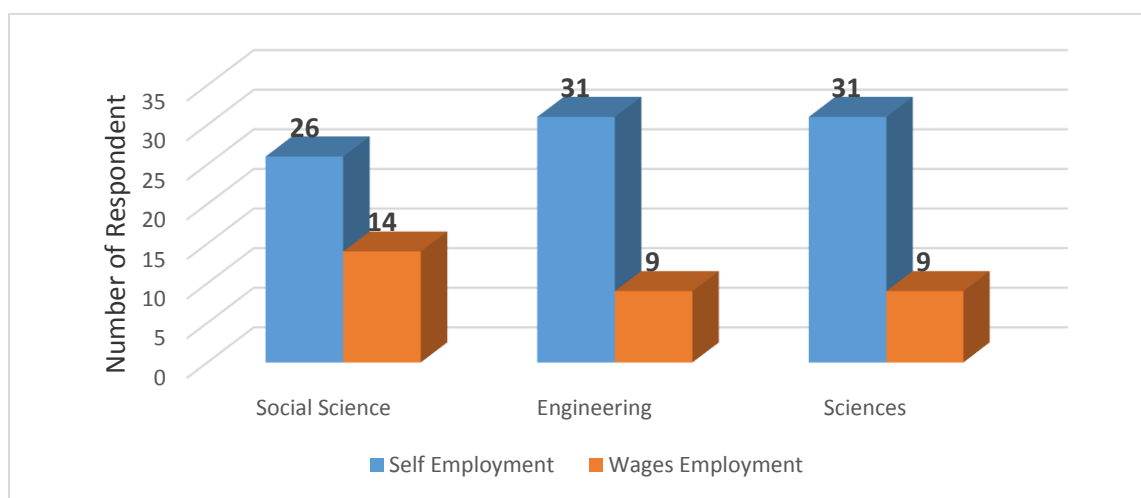


Figure 4: Relationship between course of study & Graduate Employment for Higher National Diploma Students.

Table 5: Chi-square test, displaying the value and the Sig-value (P-Value) of the association between the type of course (Social Sciences, Engineering, or Sciences) and the likelihood of owning a small business among polytechnic graduates.

Variables	N	“ χ^2 -Test (Chi-Square Test)”		Remarks at 5%
		χ^2 -Value	P-Value	Calculated level of significance.
Perception based on Graduates	240	12.150	.000	Significant

DISCUSSION

The number of administered and returned questionnaires in Tables 1 and 2 reveals the number of graduates from two polytechnics in the State who are from the Kaduna Metropolitan Authority. Whereas each Metropolitan Authority selected forty (40) graduates for both ND and HND.

According to Table 1 and Figure 1, which show the gender classification of survey respondents, 40% (48) and 50.8% (61) of respondents at the ND and HND levels in the three selected Metropolitan Authorities were men, while the rest (60% (72) and 49.2% (59) were women. One would be tempted to conclude that in each of the chosen Metropolitan Authorities, there are more females than males at the ND level. Given that the technique of data collection used stratified random sampling, this may or may not be the case.

The examination of the link between course of study and employment (self-employment and salary/wage employment) from the administered questionnaire is presented in Tables 3 and 4. According to the data, the majority of students (respondents) chose self-employment as their primary career path after graduation, with 59.2% (71) at the ND level and 73.3% (88) at the HND level. This clearly shows how entrepreneurial education has a favorable effect on

students' plans for employment following graduation. Chi-Square analysis was used to perform additional analysis on these tables.

The association between course of study and the likelihood of owning a small business among polytechnic graduates is shown in Table 5 above, with the chi-square value (12.150) and the significant value (0.000), also known as the P-Value. The test was run at a 95% level of significance, and the results were compared to the Sig Value or P-Value (0.000). Since the P-Value (0.000) is less than 0.05, we failed to accept the null hypothesis and concluded that "There is a significant association between the type of course (Social Sciences, Engineering, or Sciences) and the likelihood of owning a small business among polytechnic graduates".

CONCLUSION AND RECOMMENDATIONS

Summary of Findings

The following are the research's main findings:

According to the analysis of the relationship between courses and employment (self-employment and salary/wage employment), entrepreneurship education has a positive impact on students' inclinations to work after graduation. This is supported by the Chi-Square Data Test of Hypothesis, which shows a highly significant relationship between entrepreneurship education and the likelihood of polytechnic graduates owning a small business, as well as a significant difference in the likelihood of showing interest in self-employment and entrepreneurship between polytechnic graduates with self-employed parents and those with wage-earning parents. According to the final hypothesis, there is a substantial relationship between the course of study and the likelihood of owning a small business among polytechnic graduates.

CONCLUSION

The main data was analyzed using both descriptive statistical analysis and inferential analytical approaches. While inferential statistical techniques are used in SPSS Statistical Package version 27, descriptive statistics provide tabular presentations, percentages, and comparisons. The chi-square test found a highly statistically significant relationship between program of study pursued by polytechnic students and their employment preferences. Finally,

the study has consistently demonstrated how students have an entrepreneurial mindset and a proclivity to pursue self-employment as a career option after graduation.

Recommendations

It is hereby recommended that:

- a. In light of these findings, Nigerian polytechnics should cultivate an entrepreneurial culture among their students in order to educate them for value creation, job creation, and self-employment, all of which would lead to wealth development for both the individual and the country as a whole.
- b. Both direct and indirect methods are required to instil critical entrepreneurial attributes such as concentration, vision, discipline, creativity, risk-taking, and others.
- b. The government and institutions involved should therefore endeavor to encourage students to take on an autonomous entrepreneurial project each year of their studies that they are required to create and implement in order to reward these characteristics. This technique will considerably contribute to the development of students' entrepreneurship skills.
- d. The government might issue loans, grants, or subsidies to encourage graduates to start their own firms.

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ASSESSING IMPACT OF MECHATRONIC FARMING TECHNOLOGY ON THE ENTREPRENEURIAL SUSTAINABILITY OF NIGER STATE, NIGERIA.

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ABSTRACT

This research work and academic term-paper critically assess the impact of Mechatronic Farming Technology on the Entrepreneurial Sustainability of Nigeria under a case study and research catchment of Niger State in North-central Nigeria; it considers the challenges associated with the protracted usage of primitive mechanized farming technology in relation to the current superior adoption of modernized mechatronic farming technology; the research methodology of the term-paper utilizes the survey research method achieved through the sampling of individual units of large-scale farmers (respondents) and agriculturists farming with sophisticated (mechatronic) farm equipment, tools & machineries in a sampling population of 100 respondents encapsulating qualitative (questionnaires) and quantitative (percentages) statistical instruments in collecting data and information from the respondents via structured questions that are both close and open-ended in facilitation of computation of result that is reliable and consistent; other scholarly journals, academic term-papers and several publications are also reviewed in assessing the extent to which mechatronic farming technology impacts the entrepreneurial sustainability of Nigeria.

Keywords: *Entrepreneurial, Farming, Mechatronic Technology, Sustainable*

1.0 Background

Nigeria, a secular nation in Western Africa with landmass of approximately 1 million square meters (sqm) has about 72% of its landmass with cultivation potential, but only just about 35% of her arable land is put under actual farming; despite the high proportion of cultivated landmass relative to the total available space, food production to feed the teeming populace in the country remains a mirage, with this undesired outcome aided by the discovery of crude deposits in the nation's Niger Delta Basin followed by the advent of commercial crude-oil exploration since the early 1970s to date. Nigeria's population that is rapidly growing makes agricultural transformation necessary for the country to develop, meet her set agricultural policy target and emerge amongst the top economies of the world by 2050.

So that Nigeria can create a future where her citizens can lead a healthy and productive life, the radical transformation in her capability for food production that is not only

nourishing but readily accessible and affordable is grossly inevitable. Nigeria is currently the most populous black nation in the world and through better understanding of mechatronic farming technology shall be self-sufficient in food production with peak economic viability that precursors entrepreneurial sustainability. The need for the adoption of mechatronic farming technology in Nigeria and West Africa has become more acute in recent years due to the urgent need to accelerate food production, raw-materials processing and fibre production for the rapidly expanding urban and rural populace.

In spite of lot of progress in developing proto-types of agricultural machineries by engineers peculiar to our crops, soils and socio-economic conditions added to the huge amounts on investment in procuring agricultural machineries in the past in Nigeria, agricultural mechanization in the country continues to be very low necessitating morphing the current mechanization approach from the subsisting mechanized stock to mechatronic systems in abid to boost food availability, economic growth and entrepreneurial sustainability.

Annual review of World Bank's economic development and performances in sub-Saharan Africa reveals that from the last decade of the twentieth century up wards, enormous challenges will face Africa's agricultural productivity with Nigeria as epicenter. This includes, ensuring food security for all, contributing substantially to foreign exchange earnings through the cultivation of export crops and providing attractive and gainful employment for the rapidly population of unemployed youths (World Bank Annual Report, 2010 –2023).

Nigeria has set an ambitious target of emerging one of the top 20 economies in the world by 2050. A major task is to set the solid foundation for sustainable rapid socio-economic development that rests on synergies among the key performing sectors of the economy. A fundamental gain of Agriculture in the development and growth of Nigeria is indicated in its contribution of food security, raw materials for agro-allied industries and its immense linkage effects to employment, national income, industrialization, emergent markets and reduction in poverty and general improvement in health conditions of the nation's citizens.

Of the numerous benefits from Agricultural, Nigeria has grown to rely heavily on earnings from oil exports without making the investments needed to diversify the economy through the development of other non-oil sectors like agriculture.

The future prospects of mechatronic farming technology and its attendant impact on entrepreneurial sustainability of Niger State of Nigeria strongly rest on innovative designs and fabrication of agricultural farm tools and machines that synchronizes mechanics and electronics simultaneously that suitably adapts to changing soil conditions designs with their requisite professional expertise for manufacture, sale and maintenance of mechatronic agricultural machines, tools and equipment.

For sustainable entrepreneurial growth and food sufficiency in Nigeria, mechatronic farming practices need to be adopted by farmers especially those engaged in direct food plant cultivation in the country and other West-African sub-region as so doing will eventually obliterate the long overdue agricultural mechanized machinery stocks with low work efficiency, exorbitant purchase cost and high maintenance requirements. The researchers' aim in this research work and academic term-paper is to assess impact of mechatronic farming technology on entrepreneurial sustainability of Nigeria with Niger State in North-central Nigeria selected as the case study of the research.

The purpose of this academic term-paper is to assess and ascertain impact of mechatronic farming technology on entrepreneurial sustainability in Niger State of Nigeria. It will examine the relationships and correlation between the mechatronic farming technology levels and entrepreneurial sustainability in Niger State, Nigeria. In addition, it will establish if factors like minimized cultivation cost and other similar parameters influence entrepreneurial sustainability in Niger State, Nigeria.

This research will attempt to answer the following questions: If mechatronic farming technology impacts entrepreneurial sustainability in Niger State, Nigeria? If there is a (ny) relationship between mechatronic farming technology and entrepreneurial sustainability in Niger State, Nigeria? And lastly, If there are other factors aside mechatronic farming technology that influences entrepreneurial sustainability in Niger State, Nigeria?

The results from this research will allow for reappraising if mechatronic farming

technology truly impacts entrepreneurial sustainability in Niger State, Nigeria. This issue is one of the most important topics, not only in Nigeria, but globally, as testified by the number of papers, books and international conferences on this subject that has taken place over the last few years. Also, the issue has a high profile in Agricultural Economics, Business Management and Entrepreneurship because of series of magazine articles and television programs hosted on it. The question of the impact of mechatronic farming technology on entrepreneurial sustainability of Niger State, Nigeria is quite fundamental to our understanding of agricultural entrepreneurial evolution and resultant relationship if any exists at all.

Overview of Mechatronic Farming Technology

Mechatronic Farming Technology is the application of the fusion of mechanical, computer, electrical & electronic and control engineering (mechatronic) engineering systems (technology) to farming and agriculture with a view to revolutionizing and enhancing the productivity of human and animal labour in order to get agricultural outputs that outweighs the capacity of human, animal & mechanical labour which includes but is not limited to the use of mechatronic farming tractors, equipment & tools of various types like autonomous driverless farm tractors and drones that is digitally-powered and embedded to internal combustion engines, electric motors, machines and solar powered equipment chipped on integrated circuits (ICs) (Aisha I.G., Tajudeen L. A., (2024)).

Mechatronic Farming Technology further extends related farming equipment, tools and machines (technologies) designed and built on mechatronic operational framework aiding agricultural activities like irrigation, food processing and packaging systems on Artificial Intelligence, Robotics for smart farming. Mechatronic Farming Technology varies across different agricultural levels based on the need assessment of the mechatronic technology required and compatible with the prevailing local, socio-economic, environmental and industrial conditions.

Agriculture that is practice of soil cultivation and livestock management for plant and animal production for man's use require certain inputs relating to those vital elements needed to make farming possible, less costly and profitable. These inputs could be resources (material and non-material) needed in cultivating arable land, produce crops,

process, store and distribute them. Therefore, agricultural farming inputs can be diverse elements like arable land, capital (monetary or otherwise) and labour (human, animal or mechatronic) together with research, education, science, technology & engineering. These agricultural inputs comprise agricultural mechatronic resources which should be harnessed, controlled and organized for improved agricultural productivity. Mechatronic Farming Technology has huge potential of accelerating agricultural production that can address the current challenges of food shortage experienced in contemporary times in Nigeria (Aisha, I. G., Tajudeen, L. A., (2024)).

The agricultural system currently practiced in Nigeria needs to transit the current state of excessive reliance on utilization of moribund and out dated mechanized tools for year-round irrigated crop and animal production and raw materials processing to mechatronic farming systems to promote Nigeria's teleoperation to smart agriculture at a time the country grapples with acute national food shortage, malnutrition and hunger crisis for sustainable entrepreneurship and national development.

Therefore, the presenters of this academic term-paper and research, Aisha, I. G., & Tajudeen, L. A., (2024) saw dire need to expand research efforts on mechatronic farming technology with firm conviction that it will surely bring positive progress technologically to agricultural practices and farming in the research catchment of Niger State in North-central Nigeria considering its attendant outcome on entrepreneurial and market viability for farmers and other allied-agents in the agriculture value-chain of the state and country. Nigeria and other third world countries recognizes that food and raw materials self-sufficiency is an internal affair of their countries and that if properly articulated agricultural development plan is given priority in practice, particularly, on mechatronic farming technology, it will revolutionize and modernize the agricultural sub-sector as well as the entire economy. Through timely adoption of mechatronic farming technology, the growth rate of agricultural production in Nigeria will appreciate, mitigating hunger, starvation, diseases, joblessness, excessive dependence on import of raw materials and processed food items, thus, improving nutrition and general life expectancy in the country.

With about 90% of Nigeria's agricultural work still done with crude local farm tools, 7%

with animal-drawn tools and only about 3% with engine-powered technology, it is rational to argue that if about 70% of Nigeria's population is engaged in agriculture, then self-sufficiency in food and agricultural production is still a mirage in the country (Onwualu & Pawa, 2004).

Nigerian agriculture has been very internationally unpatrolled in terms of quality, quantity, grades, hygiene, pricing and markets and will continuously remain so until infrastructures are upgraded and mechatronic farming technology introduced and adopted through proper policy and institutional measures. Improvements in infrastructure, particularly, productive investments in land, water, markets, processing and roads is very crucial in overcoming the constraints imposed by sky-rocketing population growth combined with a shift in the ratio of rural to urban migration.

Background of Case Study (Niger State, Nigeria)

Niger State as a political entity created on 3rd February, 1976. It was carved out of the defunct North-western state by former Head of State, Gen. Murtala Ramat Muhammed alongside six other states. It commenced full administrative functions on 1st April, 1976 with seven local government areas. Niger state lies between latitude 3° 20' East and longitude 8° 11' North. It is bordered in the North by Sokoto State, in West by Kebbi State, South by Kogi State and South-West by the Federal Capital Territory – Abuja. The state also shares a common boundary with the republic of Benin in Borgu Local Government Area. The 2006 census recorded her population as three million, nine hundred and fifty thousand, and two hundred and forty-nine persons (3,950,249). The state covers a land area of about eight million hectares out of which six million hectares is arable for farming and other agricultural purpose except Minna that is the administrative capital. The natives in the state derive their source of livelihood basically from farming, fishing trading and civil service engagement.

Research Methodology

The research methodology adopted for this research study is the survey method. This method investigates the research topic, assessing impact of mechatronic farming technology on the entrepreneurial sustainability of Nigeria with a case study of Niger

State, Nigeria.

Research Population

The population of this research was drawn from large-scale farmers and agriculturists (respondents) farming with sophisticated (mechatronic) farm equipment, tools & machineries in the 25 Local Government Areas of Niger State, Nigeria out of which 100 respondents comprising both males and females assess impact of mechatronic farming technology on the entrepreneurial sustainability of Niger State, Nigeria

Sample Size and Sampling Techniques

The researchers, Aisha, I. G., & Tajudeen, L. A., (2024) drew the research sample from 100 respondents representing large-scale farmers and agriculturists (respondents) farming with sophisticated (mechatronic) farm equipment, tools & machineries in Niger State, Nigeria considering that it will be extensively difficult to study the entire population of farmers in all the states in Nigeria. Therefore, to achieve considerable sample frame for this research work, the researchers streamlined and randomly select one hundred (100) respondents who are of both male and female gender.

Instrument of Data Collection

This study made use of both qualitative (questionnaires) and quantitative (percentages) statistical instruments in collecting data and information from the respondents which contained structured questions that are both close and open ended. This is to facilitate computation of result that is credible, reliable and consistent. The instrument for this research is questions based on assessment of the impact of mechatronic farming technology on the entrepreneurial sustainability of Nigeria as it relates to economic growth, self-reliance and food sufficiency in Niger State, Nigeria.

Questionnaires

The questionnaires designed for this study contained 15 questions to elicit responses that will provide answers for the study.

Method of Data Analysis and Interpretation

The test papers (responses) are administered, collected, marked and analyzed using

simple percentages statistics for easy interpretation. The statistics were used to test the research questions earlier asked if mechatronic farming technology impacts the entrepreneurial sustainability in Niger State, Nigeria and whether there is a (ny) relationship between mechatronic farming technology and entrepreneurial sustainability in Niger State, Nigeria and conclusively, If there are other factors aside mechatronic farming technology that influences entrepreneurial sustainability in Niger State, Nigeria?

Data Presentation and Analysis

S/No.	Question	Response	Frequency	Percentage(%)
1.	Sex	Male	50	50.0%
		Female	50	50.0%
		Total	100	100%
2.	Age Brackets (years)	18 – 25	30	30.0%
		26 – 30	31	31.0%
		31 and	39	39.0%
		Above		
		Total	100	100%
3.	Do you agree that mechatronic farming technology employs digitalized farm machines, equipment and tools for smart agriculture?	Yes	100	100.0%
		No	00	00.0%
		Total	100	100%
4.	Do you practice smart farming using any mechatronic farm tools, equipment and	Yes	61	61.0%
		No	39	39.0%

	machines presently or in the past in your Local Government Area in Niger State, Nigeria?	Total	100	100%
5.	Is mechatronic farming technology used for farming in your Local Government Area in Niger State, Nigeria?	Yes	75	75.0%
		No	15	15.0%
		Total	100	100%
6.	Is farming with mechatronic farming technology in your Local Government Area in Niger State, Nigeria effective?	Yes	75	75.0%
		No	25	25.0%
		Total	100	100%
7.	Based on your farming experiences, do you believe that mechatronic farming Technology generally improves and sustains Entrepreneurship in Niger State, Nigeria?	Yes	89	89.0%
		No	11	11.0%
		Total	100	100%
8.	Does the advancement from mechanized farming to smart agriculture through adoption of mechatronic technology enhance food sufficiency in your Local Government Area of Niger State, Nigeria?	Yes	90	90.0%
		No	10	10.0%
		Total	100	100%
9.	Will extensive recommendation of smart agriculture using mechatronic technology to Niger State and general Nigerian farmer simplify food production?	Yes	79	79.0%
		No	21	21.0%
		Total	100	100%

10.	Does the practice of non-mechatronic agriculture influence entrepreneurial sustainability of Niger State and the national development of Nigeria?	Yes	36	36.0%
		No	64	64.0%
		Total	100	100%
11.	Is there a(ny) relationship between smart (mechatronic) agriculture and entrepreneurial sustainability in Niger State, Nigeria?	Yes	84	84.0%
		No	16	16.0%
		Total	100	100%
12.	Are there other variables like government policy, legislation, access to agricultural credit facility etc., aside smart (mechatronic) agriculture that influences the entrepreneurial sustainability of Niger State, Nigeria?	Yes	66	66.0%
		No	34	34.0%
		Total	100	100%
13.	What farming level should smart mechatronic (smart) agriculture be applied in Niger State, Nigeria?	Pre-Planting	36	36.0%
		Planting	05	05.0%
		Post-Planting	9	09.0%
		Allof theabove	50	50.0%
		Total	100	100%
14.	From your farming experience so far, do you	VeryWell	24	24.0%

	think the Niger State Government supports smart (mechatronic) agriculture in any way?	Partially	30	30.0%
		Notat All	38	38.0%
		Indifferent	08	08.0%
		Total	100	100%
15.	Is the acquisition of smart (mechatronic) agricultural machineries and equipments expensivein Niger State and Nigeria generally?	Highly	40	40.0%
		Expensive		
		Expensive	32	32.0%
		Inexpensive	28	28.0%
		Total	100	100%

Findings and Discussions

Evaluating the data presentation and interpretation above, the findings assesses impact of mechatronic farming technology on the entrepreneurial sustainability of Nigeria with a case study of Niger State in Nigeria. Disclosures from presentation of the data analyzed in this study are concurrent and clearly indicate that adoption of mechatronic farming technology in all the 25 Local Governments Area of Niger State, Nigeria positively impacts the entrepreneurial sustainability of the state and by extension, Nigeria.

However, the findings of the study reinforce earlier assertions of Sairoel Amertet, Girma Gebresenbet, Hassan Mohammed Alwan & Kochneva Olga Vladmirovna (2023) that similarly assessed the applications of mechatronic technology to agriculture globally.

The data also identifies certain challenges and hindrances like low agricultural financing, weak/non-existent agricultural mechatronic regulatory policies and environmental factors. In most cases farmers have to improvise and provide the agricultural smart infrastructures like driverless tractors, ploughs, bulldozers and harrowers which

invariably increases the cost of agricultural farm inputs thus making such harvests and food commodities exorbitant and expensive.

The Niger State Ministry of Agriculture and other government's agricultural regulatory agencies should not shy away from their responsibility of providing agricultural infrastructures to farmers and potential agriculturists if Niger State and Nigeria must achieve the goal of becoming entrepreneurially sustainable and emerge one of the top 20 economies by 2050 through smart agriculture in record time.

Summary of Findings

The results of data analysis above revealed that majority of agricultural inputs include diverse elements such as land, capital and labor as well as research, education, communication /information, engineering & technology. All these inputs and many more must be harnessed, controlled and organized for improved agricultural practice. For smart agricultural management to succeed, some other inputs upon which it will

Strive must be available. These include good and focused political manner of governance capable of formulating and implementing policies and laws that can accelerate economic growth and development. For instance, the current agricultural system practiced in Nigeria is heavily reliant on moribund mechanical farm machineries, hand held tools and rainfall, thus, needs to morph to mechatronically-enhanced farm implements and machineries on year-round irrigated farming and agriculture for entrepreneurial sustainability and food sufficiency.

Conclusion

This study has successfully assessed impact of mechatronic farming technology on the entrepreneurial sustainability of Nigeria with case study of Niger State, Nigeria. Based on the findings of the study, entrepreneurial sustainability of the Niger State and Nigeria constitutes a major factor in assessing smart agricultural development in the State and Nigeria which greatly impacts modernization and enhances the entire economic performance of Nigeria. This study has also succeeded in establishing that mechatronic farming technology and smart agriculture considerably boosts agricultural productivity, food stock and nutritional independence in Niger State, Nigeria. It also highlights and

emphasizes the close relationship and correlation between mechatronic farming and entrepreneurial sustainability of Niger State and Nigerian respectively.

The study brought to the fore the indispensable roles of other latent factors vis-à-vis availability of agricultural farmlands, capital, labour, research & education, communication and information as well as engineering and technology in agricultural mechatronic development in Niger State, Nigeria.

However, other forces like focused and functional governance, political administration, policies and laws in areas of agricultural mechatronization will surely influence development in Niger State, Nigeria; to this effect, some recommendations have been suggested towards solving the problems and challenges identified during the course of this study. It is hoped that these suggestions will enhance the performance of Niger State and Nigerian government, agriculturists (farmers) and the international development partners in fast-tracking agricultural mechatronization and entrepreneurial sustainability of Niger State, Nigeria.

Recommendations

From the summary of findings of this study, the following recommendation has been suggested.

1. Improvements in infrastructure—*particularly productive investments in land improvements and water control, markets, processing and roads* – are a key to overcoming the constraints imposed by high levels of population growth, combined with a shift in the ratio of rural to urban migration. It is mechatronization that will completely revolutionize the Nigerian agricultural sector through entrepreneurship particularly in Niger State, Nigeria.
2. Government should actively fund and promote research seminars and workshops for disseminating knowledge in agricultural mechatronization, entrepreneurship and agricultural production technology.
3. Government should enunciate policies that encourage engineers, technicians, technologists and fabricators to engage in local manufacture of agricultural mechatronic machine and farm implements. Thus, encourage local

manufacturers through organization of exhibitions, recognition and awards for innovation and invention on agricultural mechatronization and entrepreneurship.

4. National and International agricultural regulatory mechanisms ADP's, RBDAs', DFRRI, NARP, FEAP, NEEDS, RAIDS, CEDP & NASENI should provide technical support and partner with Universities, Research Institutes, Polytechnics, Industrialists, Manufacturers & Fabricators because, doing will surely bridge any existential gap between trihelix of the research centres (university), government and industry.
5. Government should regulate the agricultural mechanization and mechatronization value-chain by protecting local manufacturers of agricultural machinery and equipment from foreign imports and competition. Government can still go further in ensuring solid technological base for self-sustaining local fabrication and mass production of tested agricultural mechatronization prototypes by developing foundries and associated refractory materials by way of accelerating the development of materials science, engineering, steel mills, heavy engineering plants and alloy metals as a focus in fabrication of machineries, tools and spare-parts.
6. Many agricultural mechatronic tractors and may have been imported into or manufactured in Nigeria. Managing them should include scheduling them for work timely, for maintenance and repair with genuine spare parts to make them operable and making sure that only properly trained operators operate them to achieve their optimum field capacities by reducing time losses during operation.
7. The government should also provide tax incentive and relief for willing and intending agricultural mechatronization farmers, create good roads, power supply and standard telecommunication networks which will in turn will boost agriculture mechatronization and entrepreneurial sustainability in Niger State, Nigeria.

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ORGANISATIONAL INNOVATION AND PERFORMANCE OF MSMEs: A SYSTEMATIC REVIEW

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ABSTRACT

Purpose –The purpose of this paper is to examine organizational innovation performance in MSMEs. And also explore the nexus between organisational innovation and firm performance. The literature evaluated comes from peer-reviewed journals and is empirical, management-oriented research from an organizational perspective.

Design/methodology/approach – Based on the literature review, Systematic Quantitative Assessment Technique, (SQAT) is used in conducting a systematic review on 153 organisational innovation (OI) articles published over the last two decades (2000 – 2021) to provide insight as to the efficacy of the impact of organisational innovation performance in MSMEs. Besides this primary objective, this review also sought to understand the time distribution, geographical distribution, types and data collection methods of these OI articles.

Findings –Review of empirical evidence revealed that there is a positive relationship between an organisation's innovativeness and its performance. The review shows that among three aspects of organizational innovation, innovation in business practices and innovation in workplace organization has positive impact on performance of MSMEs while innovation in external relations has not. The review also indicated that interest in OI has risen year after year over the last two decades, with the majority of research taking place in Europe, Asia, and South America. Furthermore, the majority of OI research has been empirical, with surveys being the most common data collection method. In existing OI literature, There has been dearth of qualitative studies in extant OI scholarship, and this represents a significant gap which future researchers should endeavour to address.

Originality/value -This study contributes to the existing body of research OI by providing a comprehensive framework to assist practitioners and academics to understand the nexus between organizational innovation and MSMEs performance.

Keywords: organizational innovation, firm performance, manufacturing, Innovation, MSMEs

Paper type: Systematic review.

1. INTRODUCTION

The search for competitive advantage has led to the recognition of innovation as a vital ingredient for survival and profitability in the 'Information Age' (Rezaei *et al.*, 2018). Achieving higher innovation performance requires organizations to harness the knowledge, skills, abilities, opportunities and willingness of employees to innovate (Fu *et al.*, 2015). Organisational innovation (OI), the focus of this research review, is a dynamic and iterative process of creating or modifying an idea and developing it to produce products, services, processes, structures, or policies that are new to the organisation (Crossan and Apaydin, 2010). OI involve the implementation of new methods for organising routines and procedures for the conduct of work. These include, for example, the implementation of new practices to improve learning and knowledge sharing within the firm. Other examples are the first introduction of management systems for general production or supply operations, such as supply chain management systems, business reengineering, lean production, and quality-management system. Innovation occurs when the strategy is implemented through the use of new software and practices for documenting information in order to encourage knowledge sharing among different divisions. OI is the ability to generate and adopt new ideas or behaviours and is vital to enhance productivity and improving business performance (Jia *et al.*, 2018).

Organisational innovation can be achieved by introducing a new product, a new organisational structure, a new managerial practice or a change in organizational culture (Kwon and Cho, 2016). OI can be looked at from the organizational structure perspective as being the aspects related to the degree of centralisation and formalisation that affects the flow of innovative ideas and how the firm treats them from generation to implementation, how it assigns tasks among members and how it makes decisions. OI can also be looked at from the organizational change perspective as the practices it follows to address market changes and overcome resistance to change (Prasad and Junni, 2016).

Firms adopt organisational innovation to achieve business objectives in terms of operation efficiency, quality control, learning, product and process innovation, or market development (Damanpour *et al.*, 2019). As such, OI serves as an important strategic means to improve firm performance (Camison and Villar-Lopez, 2014), create value (Susantinah and Krishnawan, 2023), develop technology (Camison and Villar-Lopez, 2014; Ballot *et al.*, 2015), and achieve and sustain competitive advantage (Crossan and Apaydin, 2010). OI is the creation or adoption of an idea or behaviour new to the organization (Damanpour and Evan, 1984; Damanpour, 1996; Martin-Rios and Pasamar, 2018). In spite of the significance of OI, and the empirical contributions in the last decade (Hamel, 2009; Damanpour and Aravind, 2012; Doran, 2012; Camisón and Villar-Lopez, 2014; Ballot *et al.*, 2015), innovations in organisations include generation and adoption of technological and non-technological innovations, the technology-centric view of innovation continues to dominate (Crossan and Apaydin, 2010; Damanpour, 2014). Moreover, the limited extant research on OI is fragmented. Research from different perspectives has developed different approaches to understanding the phenomenon of OI and have conceptualised it in different ways (Arranz *et al.* 2019). Some studies have conceived OI as an antecedent and have tried to determine its effects on product and process innovation, and on firm performance (FP) (Camison and Villar-Lopez, 2014).

2. Methodology

This study adopted the Systematic Quantitative Assessment Technique (SQAT), in conducting a systematic review of the last two decades of OI scholarship. SQAT is developed by Australian researchers, Pickering and Byrne in 2014. SQAT is systematic in the way articles are assessed to determine their inclusion or exclusion in the review process, and the focus is on peer-reviewed original journal publications so as to maintain a high quality of articles (Pickering and Byrne, 2014). This Technique (SQAT) enables the researcher to identify “important geographic, scalar, theoretical and methodological gaps in the literature” (Pickering and Byrne, 2014). SQAT is logical, simple to use, and easily replicated, which are all important components of a

systematic review. SQAT recommends five important steps in conducting an effective systematic review. Each step and how it was applied in this study is described in

Table 1.

Table 1. Description and application of SQAT

S/N	Step	Application in current study
1.	Define topic	OrganisationalInnovation (OI) articles published between 2010 and 2024
2.	Formulate research questions	Five research questions: 1. What is the time distribution of OI articles? 2. In which countries were these articles written? 3. What kinds of OI articles were published? (Conceptual vs. Empirical) 4. What methods were used to collect data? 5. What are the specific themes these articles explored, and what were the major findings in each theme?
3.	Identify key words	“OrganisationalInnovation ”

4.	Identify and search databases	1. 8 databases utilized: Emerald, Elsevier, Springer, Wiley, Jstor, Taylor and Francis, Sage and inderscience. 2. “All in title search” using the phrase “Organisational Innovation”
5.	Read and assess publications	1. Abstracts of articles found were read to ensure that they were dealing with Organisational Innovation 2. Literature reviews, book chapters and conference proceedings were not included; only peer-reviewed conceptual and empirical articles.

Source: Author’s review.

A total of 153 peer-reviewed OI articles met the selection criteria from seven prominent publishers. Table 2 presents the OI article breakdown by the publisher.

Table 2. OI articles reviewed by publisher (2010-2024)

S/No	Publisher	Number of OI Articles
1.	Emerald	32
2.	Elsevier	11
3.	Springer	7
4.	Wiley	38
5.	Jstor	7
6.	Taylor and Francis	19

7.	Sage	4
8.	Inderscience	35
Total		153

3. Findings and discussion

3.1. Time distribution of OI articles

Figure 1 presents the time distribution of the 163 OI articles reviewed for this study over the last two decades, 2010–2024.

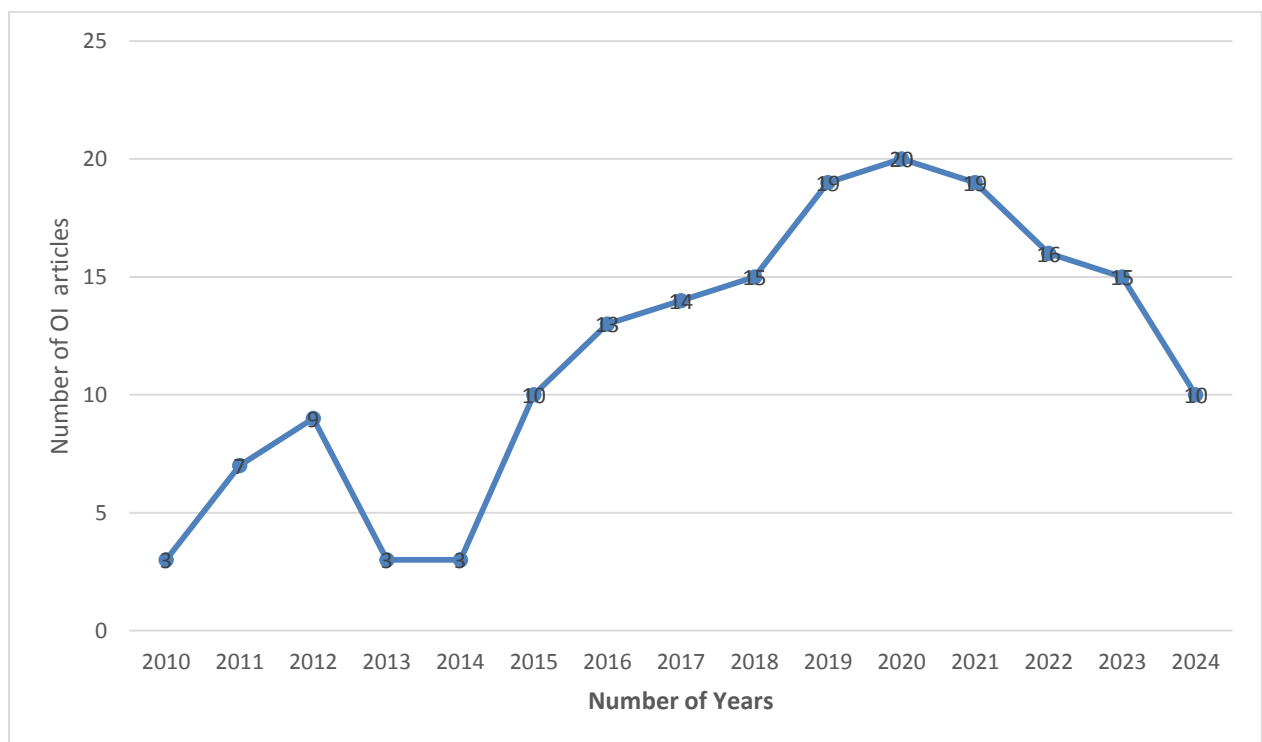


Figure 1. Time distribution of OI articles

Source: Author's review

It is observed that Time distribution of OI articles published increased as the decades went on, with 2010, 2013 and 2014 being the least productive years with one articles each, and 2020 being the most productive year with 20 OI articles published. It can

also be observed that OI articles were published in each of the 20 years covered by this review.

3.2. Geographic distribution of SL articles

A review of the 153 OI journal articles revealed that 38 countries were represented, and Figure 2 presents the top five countries from which these articles originated from over the last two decades, 2010–2024.

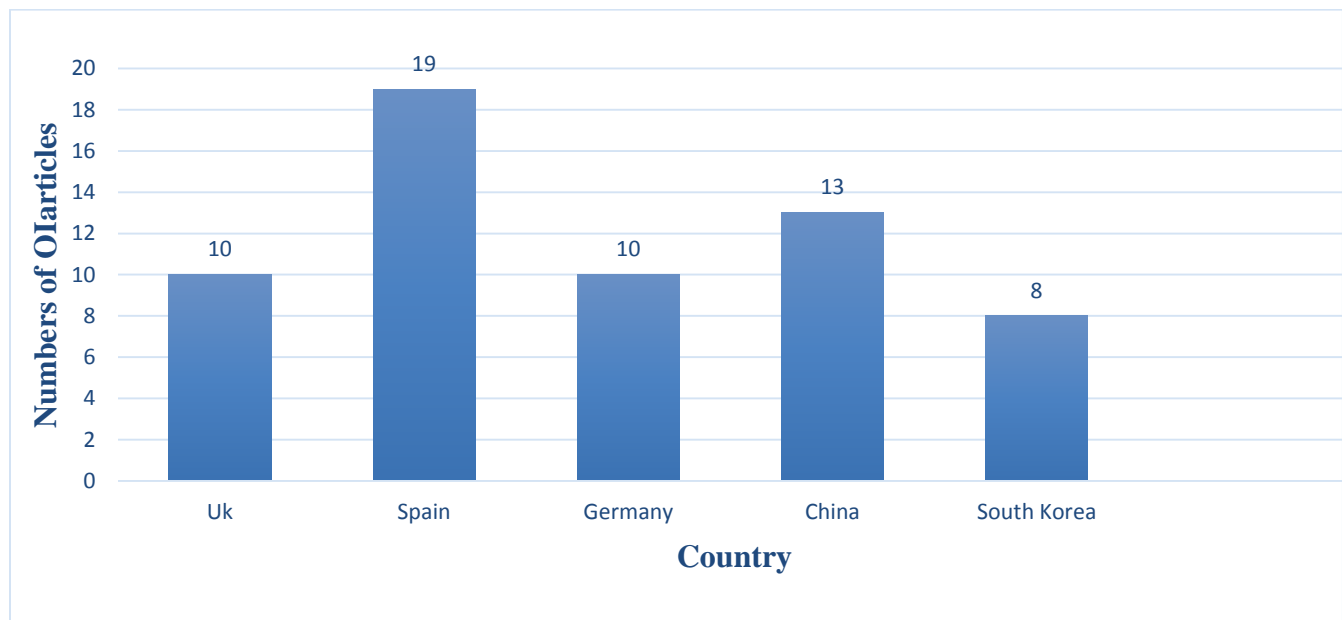


Figure 2. Countries with the most OI articles

Source: Author's review.

Spain had the most number of OI articles with 19, China with 13, followed by UK and Germany with 10 each, and then South Korea a distant fourth with eight. The remaining 33 countries and the number of OI articles associated with them are presented in Table 3.

In order to provide an additional perspective of the geographic distribution of OI articles published in the last two decades, Figure 3 provides a breakdown of the 153 articles based on the continent they originated from. It can be observed that

Europe had the largest number of OI articles published (75), followed closely by Asia (66), and then South America (6). On the other hand, Africa, Australasia and North America had (1) OI articles respectively, (Contreras, 2016).

Table 3.33 remaining countries and the OI articles associated with them

S\N	Country	Number of Articles	S/N	Country	Number of articles
1.	Indonesia	1	18	Phoenix	2
2.	Canada	1	19	Kuwait	1
4.	Pakistan	4	20	Uganda	1
3.	Turky	3	21	Ireland	1
5.	Australia	2	22	Italy	3
6.	India	7	23	Malaysia	1
7.	Netherlands	3	24	Brazil	2
8.	Austria	2	25	Jordan	1
9.	France	4	26	Begium	1
10.	Vietnam	7	27	Saudi Arabia	1
11.	Chile	1	27	Norway	1
12	Greece	1	28	Denmark	3
13	Taiwan	7	29	Iran	6
14	UAE	5	30	Tunisia	1
15	Finland	1	32	Russia	1
16	Seoul	1	33	Sweden	2
17	Texas	1	33	USA	7

Source: Author's review

Yildiz and Aykanat (2021) stated that organizational innovation influences the company's performance through improving quality of work, information exchange, capacity of learning and the use of new knowledge and technologies. The review of OI articles by continent shows that there gap in the number of articles in three continent (i. e., African, North America and Oceania has 2 articles respectively out of 153).

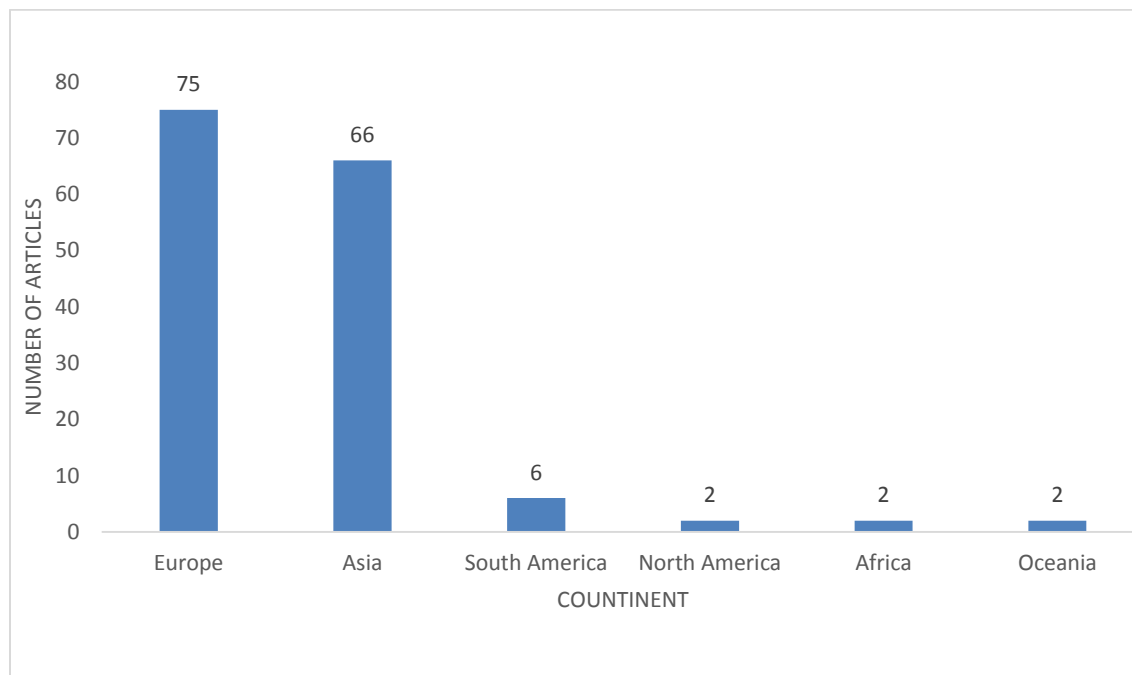


Figure3. OI articles by continent

Source: Author's review.

Organisational innovation researchers thus have a role to play in these three continents by conducting studies that will provide empirical evidences of the positive impact of organisational innovation on the performance of SMEs at micro, meso and macro levels. Perhaps such studies will help in improving quality of work, information exchange, capacity of learning and the use of new knowledge and technologies in these three continents and enhance the firm performance. Consequently, this will also improve the lives of the citizenry.

3.3 Article type

Figure 4 presents the findings on a categorization of the 153 OI articles reviewed based on whether they were empirical or conceptual in nature. It can be observed that a vast majority of the articles reviewed were empirical in nature (139 out of 153), while only 14 were conceptual in nature. Whilst empirical research is crucial to validate or disprove existing OI theories or models, Figure 4 shows that OI researchers of the last two decades have focused almost exclusively on this side of the research.

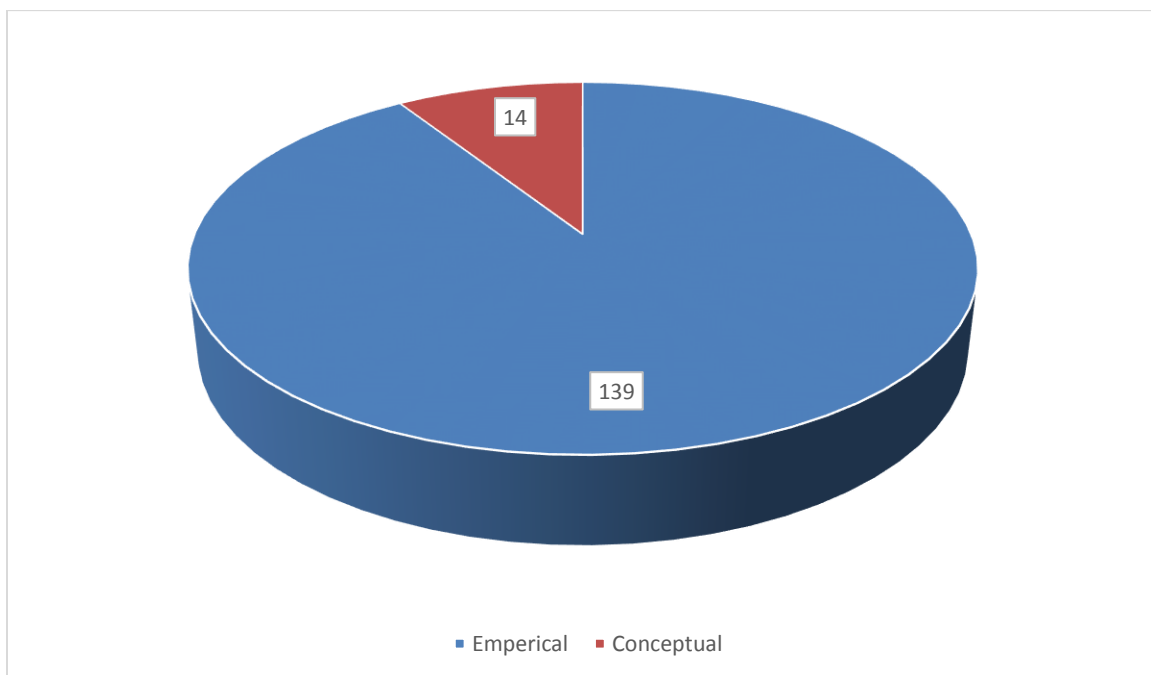


Figure 4. OI Article Types

Source: Author's review.

Conceptual research constitutes the building blocks of OI research and will establish the research agenda for the next decade of OI research. For this reason, it is important that future OI researchers focus on conceptual OI research to try to address the current imbalance between conceptual and empirical OI research.

3.4. Data collection methods

Figure 5 presents the six different data collection methods utilized by the 139 empirical OI articles reviewed for this study. It can be observed that about 77% of the articles (108 out of 139) utilized surveys to collect data; this was by far the most utilized method (For example, Liao and Wu, 2010; Bas *et al.*, 2015; Lopez-Valeiras *et al.*, 2016; Ebrahimi *et al.*, 2018; Anzola-Román and Boyona-saez, 2018; Alblooshi *et al.*, 2020; Chaubey *et al.*, 2021; Thani *et al.*, 2021). Interviews were the next most common data collection method (10 out of 139) (For example, Smith, 2016; Limsangpet *et al.*, 2022; Zahedi *et al.*, 2024), followed by observation (7 out of 137) (e.g., Fayet *et al.*, 2014; Lin *et al.*, 2020; Cai and Lonnqvist, 2021) and then documentary analysis (6 out of 139) (for example, Busaibe *et al.*, 2017). Five studies collected data from secondary sources (e.g., Crossan and Apaydin, 2010; Shi *et al.*, 2018) while three articles organized focus groups (e.g., Alves *et al.*, 2018; Pauget and Wald, 2018).

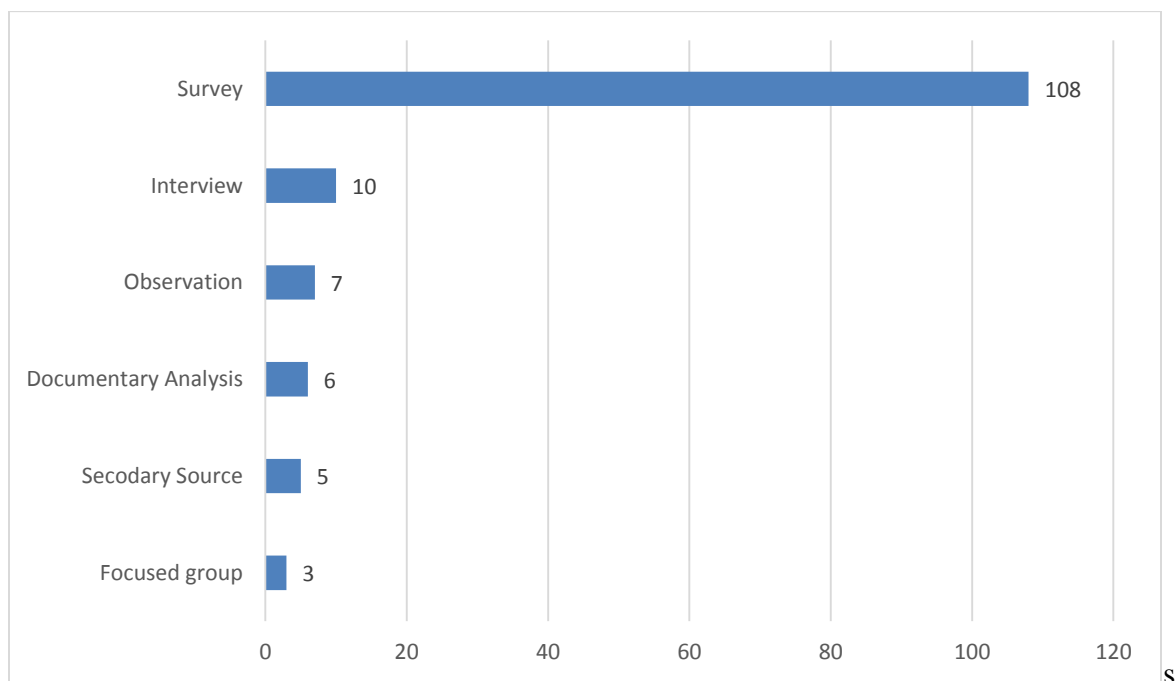


Figure 5. OI Data Collection Methods

Source: Author's review.

Figure 5 revealed an obvious quantitative bias in the way empirical data was collected by OI studies in the last two decades. Surveys allow the researchers to

collect data from large samples which make the findings more representative of the target population. However, the almost exclusive use of surveys means that rich and in-depth perspectives of OI that would be obtained via qualitative methods have not been fully explored. It is thus incumbent on future OI researchers to adopt more qualitative data collection methods to provide different insights into the OI phenomenon.

3.5. OI themes

An analysis of the 153 OI articles reviewed for this study revealed that they explored nine distinct themes which are presented in Figure 6.

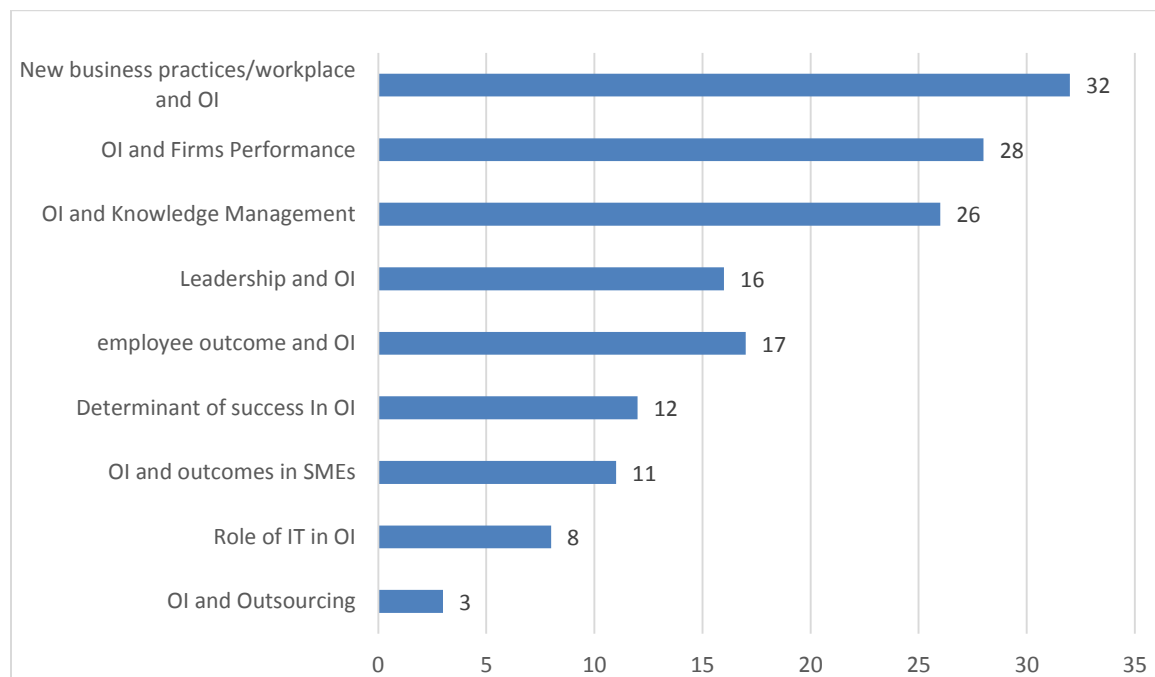


Figure 6. OI Themes

Source: Author's review

It can be observed that the vast majority of OI articles reviewed (32 out of 153) explored the effect of new business practices and methods of organising workplace on organisational innovation performance. The introduction of new business practices (e.g., Gallego *et al.*, 2013; Chen *et al.*, 2016; Lin *et al.*, 2020; Phan 2019; Haines *et al.*, 2020), new methods of

organizing workplaces (e.g., Fu et al., 2015; Rau *et al.*, 2016; Do *et al.*, 2016; Pekovic *et al.*, 2016; Phan 2019; Corsi *et al.*, 2019; Cao *et al.*, 2021). The result shows that introduction of both new business practices and new methods of organising workplace in an organisation have significant effect on organisational innovation performance.

The next most common theme explored was to investigate the outcome of OI on firm Performance. Organisational innovation outcome is the endpoint of the intellectual quest. However, linking OI outcomes with performance is critical in addressing whether and how innovation creates value. According to management scholars, organisational innovation capability is the most important determinant of firm performance (Soomro et al., 2020; Phan 2019). Two articles in this theme highlight the important linkage (Arranz *et al.*, 2019; Xiw, 2016). Indeed, this theoretical proposition has been empirically supported by several studies (Wan et al., 2015; Fu et al., 2015; Ballot et al., 2015; Ali et al., 2016). However, each group of authors has focused on different aspects of organisational innovation and used different measures of firm performance, so generalization is difficult, if impossible. Ballot et al., (2015) found a positive relationship between firm innovativeness, conceptualized as a firm's ability to change and adopt innovations, and overall profitability and objective measures of performance (ROI, ROA, and ROS). Wan *et al.* (2015) investigated the relationship between new product strategies and new product performance. Using a feedback model, Camison and Villar-Lopez, (2014) established a positive relationship between process innovation and performance measured as sales performance, sales per employee, and employment growth. Wendelken et al. 2014 found support for the relationship between new product advantage and market performance (EBITDA, ROI, pre-tax margins, and market share). Interestingly, these studies connect innovation as a process or a capability with firm performance and bypass innovation outcomes altogether (Fu *et al.*, 2015; Cheng, 2014; Caird, 2013).

On the other hand, studies concerned with organisational innovation outcomes treat them as a dependent variable and not as a mediator to performance. Understanding how OI capability delivers innovation outcomes and ultimately firm performance is paramount to managing firm innovation (Bolivar-Romos *et al.*, 2012; Ho, 2011). A possible way to advance this research is to test the connection between identified organisational innovation determinants,

and firm performance. So far, the empirical studies have used either outcomes *or* performance as a dependent variable. Including both of them in a model would reveal the role of outcomes as a mediator between OI determinants and firm performance.

The third most explored theme (26 out of 153 articles) was trying to understand to what extent the Knowledge Management (KM) phenomenon had affected the OI. (e.g., Zahedi and Khanachah, 2020; Khan and Zaman, 2020; Iqbal et al., 2020; Boroujerdi et al., 2019; Maaas et al., 2016; Findikli et al., 2015; Mafabi and Ntayi, 2012; Liao and wu, 2010). The role of business intelligence, knowledge sharing and organisational innovation on gaining competitive advantage (e.g., Lee and Song, 2015; Eidizadeh et al., 2017; Khan and Zaman, 2020; Nguyen and Malik, 2020). The role of knowledge sharing (e.g., Findikli et al., 2015; Hamdoun and Jabbour, 2018; Nguyen and Malik, 2020; Lim 2023). The interactive use of management control systems (iMCS) affects process and organizational innovation. (e.g., Lopez-Valeiras et al., 2016; Sciarelli et al., 2020). About 78% of the articles in this theme agreed that KM processes contribute to improving the level of organisational innovation through intellectual capital development. KM encourages the use of young native educated specialist to maximize internal capacity and knowledge creation and move toward improving human capital of the organisation.

Sixteen studies formed the fourth OI theme in this review by investigating the relationship between Leadership and OI. The results show that Leadership is a difficult skill that requires the ability to influence others (Nunn and Avella, 2015; Alblooshiet al., 2020; Jia et al., 2021). It is one of the most essential variables in determining organizational innovation, as leaders are often the ones that start the process by opting to introduce new and unusual ideas. Organisational innovation requires supportive leadership that encourages learning and open communication and provides individuals with the resources needed to innovate. Organisational innovation that drives performance can be either a result of a particular leadership style or some other organisational factors such as teamwork Jia et al., (2021); Robb, (2023), collaboration and learning (Nunn and Avella, 2015; Atkinson et al., 2022). Furthermore, through its impact on intervening variables such as organizational climate, strategy, and learning, which it is directly related to leadership, can indirectly enhance

organizational innovation. Such a leadership style will not be of a single approach, and instead will be a complementary approach to engage leaders and employees with each other and thereby change the organisational climate to support innovation (Noruzyet *a.*, 2012; Liao *et al.*, 2017; Nguyen *et al.*, 2021). Similarly, Nguyen *et al.*, (2023) find that leadership is one of the main contributors to organisational culture that influences innovation through organisational values, beliefs and behaviours. The importance of leadership for innovation comes from leaders' ability to establish goals for an organisational innovation strategy and communicate them to their followers while also providing reasons for pursuing them (Ismail *et al.*, 2012). Leaders set the tone for the organization, advice on strategic priorities, and foster an environment conducive to innovation (Li *et al.*, 2017). Leaders assist individuals in developing self-confidence, participating in decision-making, and setting high performance goals. They genuinely form relationships with their followers, which improves job happiness, increases work dedication, and reduces conflict (Alblooshi *et al.*, 2020; Liao *et al.*, 2017). Followers will be excited to take on challenging, risky tasks as their leaders will stand for them and provide the necessary support (Ismail *et al.*, 2012). Alblooshi *et al.*, (2020) mentions that leaders are innovators as they aim, through their actions and behaviours, for a better future by inspiring and motivating their followers to challenge routines and improve performance. As a result, innovating in order to lead is essential. Leaders foster innovation, accept difficulties, and guarantee that employees' emotions and attitudes support high levels of performance and creativity (Khan *et al.*, 2018; Chaubey *et al.*, 2019).

The next set of studies in this fifth theme explores the effect of organisational innovation on a broad range of positive employee outcomes. The positive employee outcomes included employee involvement (e.g., Yang and Konrad, 2010; Al-jlouni 2020), employee creativity and innovation (e.g., Chaubey and Sahoo, 2019; Hsu and Chen, 2015; Lewis and Moultrie, 2005; Al-jlouni 2020; Sutanto 2017; Alves *et al.*, 2018; Litchfield *et al.*, 2014), employee motivation (e.g., Wendelken *et al.*, 2014; Torre *et al.*, 2019; Hsu and Chen, 2015), employee creative behaviour (e.g., Santos-Vijande and Alvarez-Gonzalez, 2007; Liu *et al.*, 2019). Employee voice has emerged as a strong predictor of positive organizational outcomes (e.g., Rasheed *et al.*, 2017). The most striking result about the articles in this theme is that OI had a

significant effect on the various employee outcomes, providing very strong evidence of the efficacy of OI in inspiring employee to give their best efforts to the organisation.

There are twelve different determinants identified in the research evaluated. In the Open Systems Model, a specific determinant can be seen as an input or process component that clearly contributes to the organisational innovative output (AlAnazi et al., 2021). The goal was to look at a wide range of current research to see if there were any common characteristics that were found to be important in successful innovative businesses. As previously stated, specific determinants were often few in numbers due to the narrow focus of some studies.

The act of classifying the research determinants exemplifies Busaibe et al., (2017). One of the common determinants identified was an HR strategy that prioritizes innovation, which, at a higher level of 'magnification,' includes many subunits, such as training and development, that are sub-systems in and of themselves. It's easy to understand how the interconnected and cascading variables make studying innovation difficult. However Damanpour, (2020), discovered that these determinants are not always constant across investigations. This is supported in part by the findings of this study. The determinants identified are, in order of highest to lowest frequency:

- i. Management support for an innovative culture
- ii. Customer/market focus
- iii. Communication/networking
- iv. HR strategies that emphasize innovation
- v. Team structures
- vi. Knowledge management
- vii. Leadership, creative development, strategic posture, flexible structures, continuous improvement, and technology adoption.

The most commonly recurring determinant was management support for an innovative culture. Most academics agree that management aspects are critical — for example, Busaibe et al. (2017); Genter and Hecker (2013), Damanpour (2020), The determinants are categorized into two primary sets of components, management and resource factors, under

the fractal paradigm of Damanpour, (2020), emphasizing the significance of management in the whole innovation process. Knowledge management is one factor that is frequently overlooked, but as Yildiz and Aykanat (2021) points out, an organization's ability to innovate is limited by its knowledge absorption and diffusion.

The articles in this theme reveal that OI results enhanced productivity, margin, market leadership, and working environments (Laforet, 2013). However, OI does not lead to operational efficiency and employees' retention (Testera Fuertes and Herrera, 2024). Organizational innovation leads to companies operating outside their core competency but does not have an adverse environmental impact. Organizational innovation has greater impact on small firms (Laforet, 2013; Kocher *et al.*, 2010; Dukeovet *al.*,2020;Positive outcomes of organisational innovation include an enhancement of MSMEs' reputation and image, an increase in operational efficiency and cost benefits, resulting in a better business financial performance, recruitment of a more skilled workforce, and greater in-house expertise leading to further innovation. (Laforet, 2011; Haraguchi, 2019; Scuotto*et al.*,2017).Laforet, (2011), states that the negative outcomes of organisational innovation relate to management, operational issues, and financial risks; including costs, uncontrollable business growth, companies' image and reputation loss, employees and customers' issues as well as health, safety, and environmental impacts. Laforet, 2010; Laforet, 2017; Sanchez-Famoso *et al.*, 2014; Nandram and Koster, 2014; Hervas-Oliver *et al.*, 2014; Laforet, 2013). The particular findings of articles in this theme underpin apparent theoretical considerations that OI have a significant both positive and Negative outcomes on the performance of SMEs.

The next theme investigates the role of IT on OI, the findings in the articles reveals that organisational trust has a positive effect on the relationship between information system utilisation and organisational innovation (Jeon, 2019; Chatterjee *et al.*, 2020; Singh, 2011).The findings of Anzola-Román and Boyona-saez, (2018), also concurred with results of the previous studies that IT has a positive effects on both internally and externally sourced innovative practices (Ebrahimi *et al.*, 2018; Muhammad and Chelliah, 2024).

The ninth theme explores the relationship between total outsourcing, organisational innovation, and long run productivity using a model of organisational innovation. In the

model, organisational innovation is the search for new organisational architectures that more effectively bring together the externalities that exist between value-adding activities (Testera Fuertes and Herrera, 2024). Externalities exist between a set of related R&D, design, production, and marketing activities within a firm (Testera Fuertes and Herrera, 2024). There has been a rapid increase in the level outsourcing, across a wide range of areas and activities, in manufacturing and services over the last two decades. A notable growth area is the externalisation of information technology (IT) services. From 1989 to 2006, the global IT outsourcing market grew from an estimated US\$3 billion to just over US\$250 billion (Willcocks and Lacity 2006). The interesting finding of the ninth theme is that managers of a firm can become locked into a low productivity growth trajectory, associated with the outsourcing of activities, if they are myopic and learn through their own actions. They perceive outsourcing to cut overhead costs in the short-run (as expected), and so engage in further outsourcing thereafter. This is to the detriment of long-run productivity gains (system economies) which is expected to generate organisational innovation.

Table 4 presents the key findings of this systematic review of 153 OI articles published in the last two decades (2010 – 2024).

Table 4. Summary of findings of review of 153 OI articles

N/S	Heading	Key Findings	Implication
1	Time Distribution (2010– 2021)	<ul style="list-style-type: none"> • OI articles were published every year from 2010 – 2024. • 2020 was the most productive year with 20 articles published. 	<ul style="list-style-type: none"> • Interest in OI has increased over the last two decades

<p>2. Geographic distribution</p>	<ul style="list-style-type: none"> • 38 countries had at least one OI articles. • Spain had the largest number of OI articles (19) among contributing countries. • Europe had the largest number of OI articles (73) among contributing countries; while North America, Africa and Oceania had the least (2). 	<ul style="list-style-type: none"> • There is need for OI research in Africa, North America and Oceania as they were the least represented by articles reviewed.
<p>3. Article type</p>	<ul style="list-style-type: none"> • The vast majority of the articles reviewed were empirical in nature (139 out of 153), while only 14 were conceptual in nature. 	<ul style="list-style-type: none"> • There is a need for more conceptual OI research to form the research agenda for the next decade of OI scholarship
<p>4. Data collection methods</p>	<ul style="list-style-type: none"> • six different data collection methods were identified. • Survey was the most 	<ul style="list-style-type: none"> • Future OI researchers to adopt more qualitative data collection methods to

	common method used	provide different
	(108).	insights into the OI phenomenon.
5. OI themes	<ul style="list-style-type: none"> • Nine distinct OI themes identified. • About 70% of the articles investigated the relationship between OI and various new business practices/workplace • 98% of articles that examine the OI- new business practices. Workplace organisation and external relations found that OI had a significant effect on firm performance (FP). 	<ul style="list-style-type: none"> • OI is very effective in triggering new business practices, workplace organisation and external relations to give organisations the best financial and non-financial performances.

Source: Author's review.

4. Conclusion

The importance of organisational innovation on firm performance has never been more evidence than now as economic turmoil, changes in customers' demands and competitors' behaviors put high pressures on firms. Managers globally are tasked with tremendous

responsibility of finding innovative ways to meet the challenges posed by the external environment and design, produce, promote and deliver their products and services and also organize internal workflows and processes to turn their businesses in the right direction. Innovation is not just a nice thing to do but also a must for businesses to survive and succeed in this fast changing environment, hence maintaining old ways of thinking and doing things could be the quickest path to failure. It is against this background that this paper conducted a systematic review of organisational innovation over the last two decades (2010 – 2024). OI articles were reviewed across headings; time distribution, geographical distribution, article type, data collection methods and OI themes, with key findings and their implication for knowledge and practice discussed for each heading.

Perhaps the most important finding of this review was the fact that significant empirical evidences exist regarding the positive impact that organisational innovation have on the firm performance. Based on the review this study finds that among three aspects of organizational innovation, innovation in business practices and innovation in workplace organization and are significantly positively associated with firm performance while innovation in external relations is not.

In developing countries (like Nigeria), firms have lower access to information and their property rights are not well protected. Therefore, it is hard for them to follow their counterparts in developed countries in innovation (Nguyen *et al.*, 2016). Under such an institutional uncertainty and resource-deficiency environment (Nguyen *et al.*, 2013), it is easier to understand why firms in developing countries implement organizational innovation more frequently compared to any other types of innovation (Phan, 2019). The more they implement it, the more experienced they become, which, in turn, helps them to achieve better performance. This explains why organizational innovation has a positive impact on the performance of firms.

This review had certain limitations which future researchers can address, first, it only relied on journal articles published by seven of the most popular academic publishers; Emerald, Elsevier, Sage, Springer, Taylor and Francis, Wiley and Jstor. Although this was done to ensure quality of articles reviewed, it means that other valuable OI articles not published by

these publishers have been excluded. Further researchers can widen the articles selection criteria to increase the robustness of the review. A second limitation is the fact that only articles with the phrase “organisational innovation” in their titles were included for the selection; some OI articles might not have included that phrase in their titles and thus are not captured by this review.

Organisational innovation involves the search for new organisational designs that alter the internalorganisational structure of the firm, and change the boundary between the firm and markets(verticalisation / de-verticalisation). As just described, it is a search process that is conducted withina complex search space containing many dimensions, and in which the dimensions are related to oneanother in highly non-linear ways. Dealing with this organisational complexity requires managers toengage in ongoing strategic experimentation and learning. It is this ongoing problem-solving activitythat drives organisational change and innovation over time.

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NEWSPAPER COVERAGE OF 2023 FLOOD ISSUES IN NIGERIA: AN ASSESSMENT OF THREE SELECTED NEWSPAPERS IN NIGERIA.

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ABSTRACT

The largest economy in Africa is Nigeria, with approximately 202 million people. Nigeria has several issues with floods being one of the most significant with wide-reaching repercussions. The goal of this research is to look at how the Newspaper covered 2023 flood issues within the months of April to October 2023. Three national newspapers were purposively picked for the study (The Guardian, The Nation and Punch). The study's four research questions were supported by statistics showing that Nigerian publications covered the 2023 flood. The study was anchored on Agenda Setting Theory. The quantitative study used content analysis and coding sheets to obtain data. The analysis of 386 chosen newspaper editions used simple random sampling. Only 386 flood tales were discovered in tested papers throughout 7 months. The study indicated that selected Nigerian media prioritise flood coverage in news articles. Results also revealed that news was covered most often. Findings also found that some newspapers handled flood concerns negatively. The study found that chosen publications prioritise flood coverage thereby determining society's agenda. Finally, Nigerian newspapers gave substantial coverage to flood issues in the 2023. The study recommends timely, impartial, and accurate positive information before, during, and after floods as this will save lives, reduce property damage, enhance public knowledge, and empower individuals to take proactive flood protection measures.

Keywords: *flood, press, coverage, newspaper and Nigeria*

INTRODUCTION

Society uses mass media to monitor, understand, connect, value transfer, and enjoy Dominick (2002:34) referenced by Popoola (2014). Popoola (2014) quoting Mu'azu (2002:47) the press fulfils the role of an observer, contributing to the maintenance of economic, political, cultural, and moral stability within the polity by performing its surveillance function. According to Popoola (2014) in Odunewu (1995:7), mass media shape society. According to him, their goal is to illuminate force dynamics rather than merely record events.

The media preserves local culture, encourages communication between different segments of society to enhance human and material development, disseminates development-focused information, and supports social programmes and other developments. Sanusi et al. (2022) citing Baki (2015). According to Sanusi et al. (2022), quoting Mustapha (2012), mainstream media makes persons aware of differ of information in the society, which impacts what they know, believe, and do. Therefore, the press plays a critical and significant function in the country's polity. Setting the political, social, and other public agendas influences individuals and teaches them about their society (Santas and Ogushi, p. 2017).

Newspapers influence public opinion, economic growth, and global understanding, according to Popoola (2014). He believes the newspaper plays vital functions in society. These encompass the preservation and dissemination of information, support for collective goals, promotion of cultural development, education of individuals, facilitation of knowledge and idea interchange, provision of entertainment, and building of unity among individuals with common purposes. In accordance with Felix and Olanihun (2021) citing Heaven &Obaje (2021), intellectuals and politicians worldwide have lauded the media, especially newspapers, for contributing to every functional society.

According to the United Nations Office for Disaster Risk Reduction (2012), 30% of worldwide natural catastrophes are floods. These occurrences affect people and communities and take a financial toll on public services, infrastructure, and private and commercial property. Individuals, private businesses, and non-governmental groups must manage flood risk to adapt to flood dangers, according to recent flood policy changes. Flood protection solutions are expensive, thus people are putting up with the risk (Butler and Pidgeon, 2011; Scott et al., 2013).

In Nigeria, flood is the most widespread natural disaster. According to Aja and Olaore (2014), a significant number of Nigerian states are currently seeing annual flooding occurrences throughout the rainy season. These floods can be attributed to the increased precipitation resulting from climate change. The management of rainfall floods may be effectively addressed by appropriate preparedness and the implementation of infrastructure,

distinguishing it from other types of natural disasters (Agbonkhese et al., 2014; Satterthwaite, 2017).

Another sign of the low priority given to controlling and managing flooding in Nigeria at all three levels (federal, state, and local) is the lack of relevant legal and policy frameworks, and the government has made little to no effort to solve this problem. There is no legislative framework or flood management policy to handle this persistent issue (Adekola and Lamond 2018; Akinloye 2018). The government has made little effort to fix this problem because to a lack of streamlined relationships and awareness of how flooding affects Nigeria's (Akinloye 2018).

Fluvial, coastal, and pluvial floods plague Nigeria's rural and urban areas. Fluvial flooding occurs when rivers overrun their natural and manmade barriers, whereas coastal flooding predominantly impacts coastlines. However, severe storms cause unanticipated pluvial flooding. Despite failing, stakeholders' hazard mitigation attempts have been criticised for being ad hoc, poorly planned, ungeneralizable, and unestablished (Obeta, 2014).

The rising number of flood-related deaths and the barriers to sustainable development imply that the nation's flooding expertise lacks feasible solutions. According to the 2023 World Bank estimate, Nigeria's 202 million population is a major issue.

Nigeria's massive floods and handling have garnered notice. Most disputes have focused on small communities, geographical areas, and states. Poor implementation tactics and inability to confront the threat have been major issues for the nation. However, environmental and infrastructural design, legislative directives, societal reactions, physical intervention, and better public awareness have addressed this issue. This study will critically examine newspaper coverage of flood issues in Nigerian dailies throughout the rainy season of 2023.

RESEARCH OBJECTIVES.

- 1) To determine the Frequency of Newspapers Reportage on Flooding Issues stories in selected newspapers.

- 2) To find out the nature of stories reported on Flooding Issues in selected newspapers.
- 3) To know the story placement in the newspapers on Flooding Issues stories in selected newspapers.
- 4) To know the angle at which 2023 flooding issues was covered in the selected newspaper?

REVIEW OF RELEVANT LITERATURES

Flood update in Nigeria

Dataphyte 2023 reports that 29 states are unprepared for 2023 floods, and several governments at all level failed to undertake flood management activities in the first quarter. Dataphyte evaluated 1st quarter 2023 Nigerian state budget execution reports.

XS

How states performed on their 2023 budget for erosion and flood control in Q1 2023

At the end of Q1 2023, only 7 states in Nigeria implemented a part of their budget for flood and erosion control.

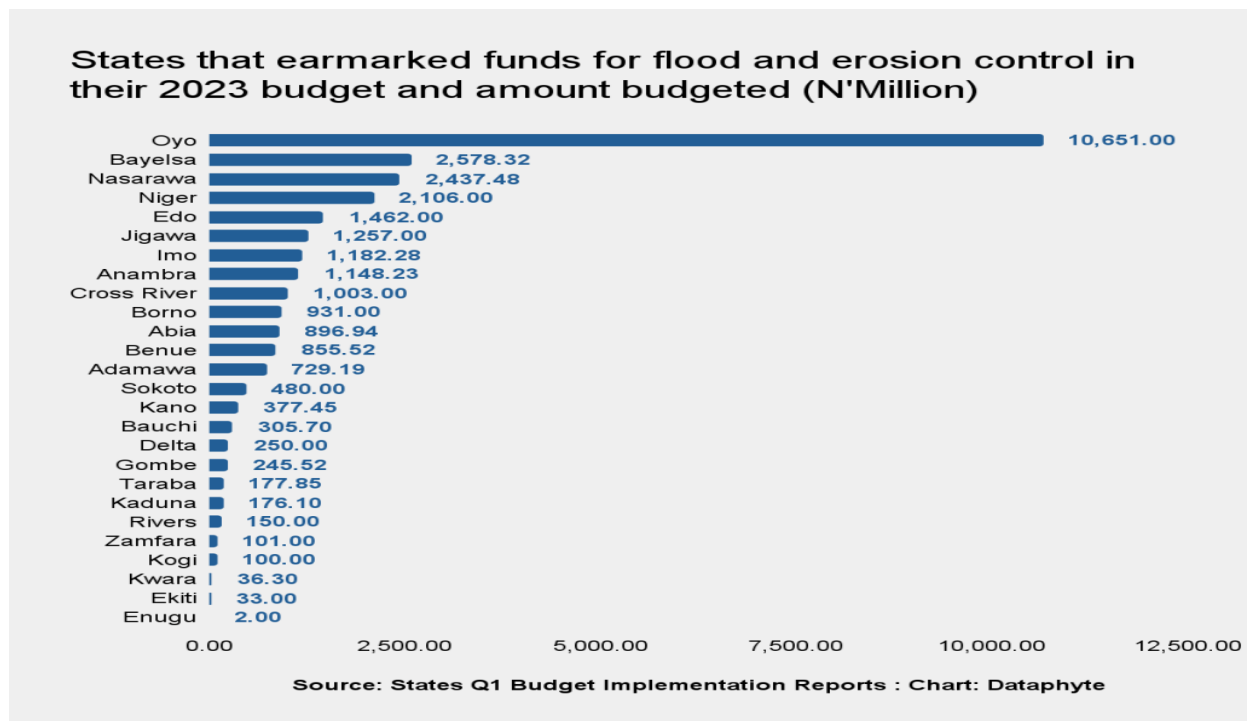
State	Budget for erosion and flood control	Amount spent in Q1	% performance
Delta	305.7m	177.94m	58.21%
Abia	931m	305.7m	32.84%
Jigawa	1.46bn	402.55m	27.53%
Ekiti	36.3m	8m	22.04%
Bayelsa	10.65bn	1.93bn	18.08%
Kaduna	177.85m	28.41m	15.97%
Edo	2.11bn	12.75m	0.61%
Oyo	16.29bn	0	0.00%
Nasarawa	2.58bn	0	0.00%
Niger	2.44bn	0	0.00%
Imo	1.26bn	0	0.00%
Anambra	1.18bn	0	0.00%
Cross River	1.15bn	0	0.00%
Borno	1bn	0	0.00%
Benue	896.94m	0	0.00%
Adamawa	855.52m	0	0.00%
Kano	480m	0	0.00%
Bauchi	377.45m	0	0.00%
Gombe	250m	0	0.00%
Taraba	245.52m	0	0.00%
Zamfara	150m	0	0.00%
Kogi	101m	0	0.00%
Kwara	100m	0	0.00%
Enugu	33m	0	0.00%
Ebonyi	2m	0	0.00%

Table: Dataphyte • Source: States Q1 Budget Implementation Reports • Created with Datawrapper

Source: Field Work, 2023

According to the NEMA website, all 36 states and the FCT were damaged to varying degrees. In 36 states and FCT, 4.47 million people were affected by the floods, with 665 deaths. Over 3,000 flood victims suffered. Other homes and farms suffered.

Following these damages, federal and subnational governments were obliged to budget for flood and erosion control in 2023 to prevent future disasters. Many states budgeted for flood and erosion management in 2023. Dataphyte found that several states did not initiate flood and erosion control projects after evaluating their Budget Implementation Reports. Many states didn't fund flood and erosion control. All 36 states' 2023 budgets except 9 covered flood and erosion control. Seasonal climate estimates and annual flood outlooks from NiMet and NIHSA projected major floods. NIHSA Director-General Clement Nze predicted devastating flooding in 178 LGAs in 32 states and the FCT in 2023. Thus, advised nations and agencies to act early to avert disasters.



Source: Field Work, 2023

Reliefweb reports that the National Emergency Management Agency (NEMA) has warned of fast flooding in the River Niger and River Benue Basin. The Lagdo Dam in Cameroon released water, causing this alarm. NEMA urges Adamawa, Benue, Taraba, Nasarawa, Kogi, Anambra, Edo, Delta, Rivers, and Bayelsa to adopt emergency response plans immediately.

According to the latest Adamawa State Emergency Management Agency (ADSEMA) report, flooding have displaced about 8,504 houses and 51,043 people. Women, children, and the elderly are most impacted. These affected people live in 11 temporary settlements in Yola South, Yola North, Lamude, Madagali, and Demsa LGAs. A total of 33 deaths were reported.

According to Hajiya Fatima Kasim, NEMA's Director of Planning, Research, and Forecasting, 33,983 people have been affected by the 2023 floods nationwide

The Nigerian Hydrological Services Agency (NIHSA) Annual Flood Outlook showed that 178 local government districts in 32 states and the FCT are in flood-prone areas. The agency said that they had collected data on flood victims nationwide over the previous seven months.

The speaker reported 10 states affected by the event. At least 33,983 people were impacted, with 7,353 displaced and 75 injured. Tragically, 5 died. The disaster also damaged 1,679 homes and 866 hectares of agriculture.

The 2015 Nigerian flood risk analysis evaluation by Komolafe, Adegboyega, and Akinluyi was extensive. They stressed the need of analysing flood impacts in the country using hazards mapping and modelling, exposure assessment, and vulnerability assessment. The study concluded that state-of-the-art flood models, which incorporate all hydrological processes, should be better investigated for flood prediction and mapping.

In environmental and rainfall intensity analysis to solve the problem of flooding in Owerri urban between 2006-2013, Nwachukwu, Alozie C, Alozie G. (2018) found that refuse-blocked drainage, buildings obstructing natural drainage, increasing urban cementation, and the low topographic landscape were major causes.

Adetunji and Oyeleye (2013) examined the causes and effects of flooding in Apete, Oyo State's Ido local government district. A total of 156 questionnaires were distributed among

the population of the Apete area. The research findings reveal a predominance of inappropriate waste management practises among the population of Apete. The concerned parties discarded trash carelessly, blocking the meagre drainage system.

In their study "Nigerian Newspaper Coverage of Climate Change," Akpan, Anorue, and Ukaonu (2010, p.23) found that the media is vital in informing the public about environmental and health issues. According to Yalaju (2006, pp.165-166), the press guides the government and society towards conflict and disaster resolution methods that emphasise individual needs and well-being. The press, representing society, has an edge in researching a nation's diverse and convergent characteristics. This study may improve national communication and federating unit respect and understanding.

Gambo (2018) examined how Nigerian newspapers covered the 2012 flooding catastrophe. This study examined the newspapers' dominant frames and which ones received the most publicity. Content analysis was used in this investigation. Research showed that scholarly publications generally focused on catastrophic narrative structure, varying in their depth and comprehensiveness of disaster coverage. The study suggests journalists should focus on actual measures and intellectual frameworks rather than politics.

According to Nkwunonwo's (2016) analysis of flooding and flood risk reduction in Nigeria, rivers Niger, Benue, Ogun, and Hadeja may cause more floods in Niger, Adamawa, Oyo, Kano, and Jigawa states. However, it is noteworthy that Lagos state has met a substantial fraction of the country's flood events. The quick rise of population and urbanisation in the country has led to a major increase in the danger of floods, posing grave hazards to both human lives and properties.

In their comprehensive analysis of the idea of flooding, Cirella and Iyalomhe (2018) go into the various aspects and implications of this phenomenon. Sustainability-focused best practises in Nigeria show that flooding in Nigerian cities has become a chronic problem, causing economic problems throughout the rainy season. Both the government and residents have tried to fix this problem, but the results have been disappointing. Proactive, standardised, and reliable practises are needed to restore urban socioeconomic growth.

THEORETICAL FRAMEWORK

AGENDA THEORY

Walter Lippmann created agenda setting theory in 1922, Cohen extended it with his 1963 epigram, and McCombs and Shaw popularised it in 1972 after examining the 1968 presidential election. Setting media agendas addresses public issues. Usua (2018, 124). Media influence processes like agenda-setting contribute to society's greatest problems, according to Lavraka (2008, p. 75).

Media determine the agenda for society (Falarin, 2002, p.75). Raman (2012, p. 44) thinks media coverage reflects popular opinion, whereas Baran (2013, p.330) believes the media sets agendas beyond story space and placement. According to Wogu (2008, p.139), people appreciate media stories and they raise major societal issues. Media coverage of the 2012 flood affected Nigerian priorities.

The idea suggests that mass media influences most of our mental pictures, thoughts, anxieties, and conversations (Asemah, Nwanmuo, and Nkwam-Uwaoma 2017, p. 75). Press is more than news. Lippmann's views were refined by Cohen into agenda setting theory. According to Ndolo (2006), Usua (2017), Asameh et al. (2017), and Nwala (2019), Walter Lippmann (1922) established the agenda in "Public Opinion," saying that mass media constitute the main link between world events and popular perspectives McCombs (2014, pp. 1-2) claims that Walter Lippmann's 1922 classic "Public Opinion"'s chapter "The world outside and the picture in our heads" started this impact.

Media can change our mental representations, says Usua (2017, p.123 in McQuail, Okpoko, and Azienga 2005). When an audience pays attention to a problem, they value it (Omego and friend 2013, p. 142). Mediating their worldview substantially impacts media priorities, which influence public priorities. After reading about flood tragedies in the press, citizens took precautions.

METHODOLOGY

This research used content analysis method. This study concentrated on the examination of flood-related narratives as published in Nigeria's daily newspapers. The months investigated were April–October 2023. The computation produces 214 days. This timeline was chosen since Nigeria had many floods during this time. For this study, 214 issues of each of the three newspapers were sampled. Thus, 642 editions were examined ($214 \times 3 = 642$).

This analysis examines all 642 daily issues of The Guardian, The Punch, and The Nation. These newspapers ran in April–October 2023. The sample includes all chosen publications' April and October 2023 flood coverage. The Taro Yamane formula was employed by the researcher in order to ascertain the appropriate sample size.

where: n = the sample size

N = the population size

e = the accepted sampling error

the needed sample size at a 95% confidence level with $(0.10)^2$

N = Population size 642

$$n = \frac{N}{1 + N(e)^2}$$

Where n – the sample size

N – the population size

e – the acceptable sampling error

At confidence level is 95% Then, Margin of error (e) is 0.05

$$n = \frac{642}{1 + 642(0,05)^2}$$

$$n = \frac{642}{1 + 642(0,0025)}$$

$$n = \frac{642}{1 + 1.605}$$

$$n = \frac{642}{2.605}$$

$$n = 246.4$$

$$n = 246$$

Therefore, the sample size is 246.

Each national daily examined 82 dailies over seven months since the sample size was divided among the three selected newspapers ($246/3 = 82$).

Random sampling was utilised. Tejumaiye (2003), mentioned in Felix (2018), indicates the purposive sample is chosen based on specified qualities or features. Data gathering tools are the coding sheet and instructions. The selected newspapers were picked for their coverage of national and international problems, availability, and editorial quality. Percentages and frequency tables were cross-tabulated to examine the issue. The following content categories were constructed to identify and assess flood issues in the newspaper articles:

Newspaper Identity: (i) The Guardians (ii) The Nation (iii) The Punch

Frequency of Newspaper coverage : (i) The Guardians (ii) The Nation (iii) The Punch

Type/Nature of Story: (i) Editorials (ii) Feature (iii) News (iv) Opinions (v) Pictures

Placement of Stories: (i) Front page (ii) Inside page (iii) Back page

Category of Stories: (i) Negative (ii) Positive (iii) Neutral

Period: (i) April (ii) May (iii) June (iv) July (v) August (vi) September (vii) October

DATA PRESENTATION AND ANALYSIS

This study examined how three particular newspapers covered flooding issues in Nigeria. Only 246 of the 642 newspapers in the sample were examined. The 82 dailies make up the aspect that is being analysed from each newspaper. The three publications received the same amount of representation making 246. The analysis of the provided data is shown in the tables below.

TABLE 1: FREQUENCY OF THE NEWSPAPER COVERAGE OF 2023 NIGERIAN PRESIDENTIAL ELECTION.

NEWSPAPER	FREQUENCY	PERCENTAGE
GUARDIAN	142	36.8%
THE NATION	118	30.6%
THE PUNCH	126	32.6%
TOTAL	386	100%

SOURCE: CONTENT ANALYSIS, 2023.

The table above shows the frequency of stories on newspaper coverage of flooding issues in 2023 within in the Guardian, the Nation, and the Punch within April, 2023 and October2023. There were a total of 386 stories of flooding issues. The Guardian newspaper had the highest frequency of such stories at 142 (36.8%), the Punch had 126 (32.6%), while the Nation had 118 (30.6%). By implication, the three selected newspapers covered the flooding issues within 2023 in Nigeria.

TABLE 2: NATURE OF STORIES REPORTED ON FLOODING ISSUES IN SELECTED NEWSPAPER

THE GUARDIAN			THE NATION			THE PUNCH		
TYPE OF	FREQUE	%	TYPE OF	FREQUE	%	TYPE OF	FREQUE	&

STORY	NCY		STORY	NCY		STORY	NCY	
EDITORIAL	3	2.1%	EDITORIAL	2	1.7%	EDITORIAL	2	1.6%
FEATURES	7	4.9%	FEATURES	4	3.4%	FEATURES	4	3.2%
INTERVIEW	3	2.1%	INTERVIEW	1	0.8%	INTERVIEW	0	0%
LETTER TO EDITOR	0	0%	LETTER TO EDITOR	0	0%	LETTER TO EDITOR	0	0%
NEWS	112	78.9%	NEWS	97	82.2%	NEWS	103	81.7%
OPINION ARTICLE	0	0%	OPINION ARTICLE	0	0%	OPINION ARTICLE	1	0.8%
PICTURES	16	11.3%	PICTURES	14	11.9%	PICTURES	16	12.7
TOTAL	142	100%	TOTAL	118	100%	TOTAL	126	100%

Source: Field Work, 2023

The table above displays all research units of analysis and their data. The Guardian published 112 news articles (78.9%), The Nation 97 (82.2%), and Punch 103 (81.7%). The total number of editorials published throughout the research period was 7 in all. Within the research period, The Guardian published 3 (2.1%), The Nation 2 (1.7%), and The Punch 2

(1.6%). In the research period, 15 features were published: 7 (4.9%) by The Guardian, 4 (3.4%) by The Nation, and 4 (3.2%) by The Punch. The Guardian published 16 (11.3%), The Nation 14 (11.9%), and The Punch 16 (12.7%) of 46 photographs. One opinion piece (0.8%) was published by punch. During the research period, The Guardian published 3 (2.1%) interviews, The Nation 1 (0.8%), and The Punch none of the same issue. During the research period, The Guardian published 142 editorials, features, interviews, news, and photographs (36.8%). The Nation published 118 (30.6%) and The Punch 126 (32.6%) of the identical article during the research.

**TABLE 3: PLACEMENT OF STORY ON FLOODING ISSUES STORIES IN THE
SELECTED NEWSPAPER**

THE GUARDIAN			THE NATION			THE PUNCH		
PLACEMENT	FREQUENCY	%	POSITION	FREQUENCY	%	POSITION	FREQUENCY	%
FRONT	18	12.7%	FRONT	9	7.6%	FRONT	10	7.9%
INSIDE	124	87.3%	INSIDE	109	92.4%	INSIDE	116	92.1%
BACK	0	0%	BACK	0	0%	BACK	0	0%
TOTAL	142	100%	TOTAL	118	100%	TOTAL	126	100%

Source: Field Work, 2023

According to the chart above, the three daily produced 386 news pieces, 37 of which hit the front pages (The Guardian had 18, The Nation had 9, and The Punch had 10). The three daily produced 349 inside articles, with The Guardian having 124, The Nation 109, and The Punch 116. The three selected newspapers had no back-page news articles during the research.

**TABLE 4: WHAT ANGLE OF 2023 FLOOD WAS GIVEN MORE ATTENTION BY
THE SELECTED NEWSPAPER?**

NEWSPAPER	POSITIVE	NEGATIVE	NEUTRAL	TOTAL
THE GUARDIAN	13 (9.2%)	121 (85.2%)	8 (5.6%)	142 (100%)
THE NATION	11 (9.3%)	101 (85.6%)	6 (5.1%)	118 (100%)
THE PUNCH	8 (6.3%)	113 (89.7%)	5 (4.0%)	126 (100%)
TOTAL	32 (8.3%)	335 (86.8%)	19 (4.9%)	386 (100%)

Source: Field Work, 2023

Data in the table above shows the directions of all the news stories published by the three newspapers under the period of study. The Guardian published 13 (9.2%) positive news stories (ie stories containing efforts made by state and federal governments to combat 2023 flood in Nigeria). 121 (85.2%) negative stories (ie stories containing destruction of properties, numbers of death, various communities and people displaced by the 2023 flood), and 8 (5.6%) neutral stories. The Nation published 11 (9.3%) positive stories, 101 (85.6%) negative stories and 6 (5.1%) neutral stories under the study period. The Punch published 8 (6.3%) positive stories, 113 (89.7%) negative stories and 5 (4.0%) neutral stories.

In all, a total of 386 (100%) news stories were published from the selected editions of the three newspapers, out of which 32(8.3%) were positive stories, 335(86.8%) were negative stories and 19(4.9%) were neutral.

DISCUSSION OF FINDINGS

The analysis found that the Guardian newspaper covered flood concerns in 142 pieces (36.8%). on 126 stories (32.6%), the Punch covered floods, while the Nation did on 118 (30.6%). The three chosen periodicals covered Nigeria's 2023 flooding incidents, according

to the information. Popoola (2014) cited Unah (1995:29) to argue that news media spreads and emphasises social events, people, and issues to a large audience. Stressing that the press is an institution that communicates, gathers, and distributes information, both internally and externally.

News coverage dominates flood narratives, according to a research. During the research period, The Guardian published a total of 142 items, accounting for 36.8% of the content. These materials spanned a number of formats, including editorials, features, interviews, news stories, and photographs. The findings of the study indicate that The Nation published a total of 118 things, accounting for around 30.6% of the total items examined. Similarly, The Punch published 126 pieces, representing roughly 32.6% of the same set of things during the research period. This shows that the flood catastrophe in 2023 gained great media attention. Akpan, Anorue, and Ukaonu (2010, p.23) found that the press influences the government and society to adopt conflict and disaster resolution strategies that prioritise individual welfare and interests. The press, working for society, has an edge in studying a nation's distinctive and convergent qualities.

Most flood-related stories appeared on the newspapers' inside pages. The Guardian had 124 such reports, the most. The Punch and Nation followed with 116 and 109 reports, respectively. Notably, these topics received minimal attention on the front pages of the newspapers, with Guardian obtaining the greatest proportion of 12.7% in this respect. The data shows that the Guardian dedicated 12.7% of its front-page lead to news pieces and The Nation 7.6%.while the Punch dedicated 7.9% front pages to the flood issues. This is similar to agenda-setting, Ndolo (2006), Usua (2017), Asameh et al. (2017), and Nwala (2019), Walter Lippmann (1922) established the agenda in "Public Opinion," saying that mass media constitute the main link between world events and popular perspectives McCombs (2014, pp. 1-2) claims that Walter Lippmann's 1922 classic "Public Opinion"'s chapter "The world outside and the picture in our heads" started this impact.

Analysing all 386 news stories regarding the 2023 flood indicated that the government's response and mitigation measures failed. Of 386 news pieces in the chosen editions of the three newspapers, 32 (8.3%) were favourable, 335 (86.8%) were negative, and 19 (4.9%)

were neutral. The press, according to Unah (1995:29) in Popoola (2014), is present in and accessible to the state and engages in communication, information collecting, and distribution. This supports Adekola and Lamond (2018) and Akinloye (2018)'s claim that there is no legislative framework or flood control policy to address this recurrent issue. This subject has been neglected by the government due to a lack of streamlined relationships and knowledge of how floods impacts Nigeria.

CONCLUSION

Flooding has become an annual event in Nigeria where it consistently causes economic problems in the rainy season. The mass media remain the most viable forces in creating awareness, raising consciousness and improving public knowledge on broad social political and environmental issues. This study was carried out to determine the Newspaper coverage of flood issues in Nigeria in 2023. This exemplifies the prevailing risk and cautionary communications, as well as the informational content, pertaining to floods disseminated through various media platforms. However, the occurrence of flood catastrophes persists annually throughout the rainy season in the country. The occurrence of floods in Nigeria posed a significant danger to both the societal harmony and economic stability of the affected towns. The press is expected to continue fulfilling its surveillance role, which involves reporting on events like as floods, and serving as a societal watchdog throughout all regions of the country.

Based on the findings of the study, the subsequent conclusions were derived:

- The extent of media coverage of the 2023 flood in Nigeria was sufficient.
- It is noteworthy that the Nigerian press paid significant attention to the 2023 flood in their news coverage mostly.
- The media prioritised the coverage of negative narratives, including incidents of death, displacement of individuals and communities, and the destruction of buildings and infrastructure.

The following recommendations are suggested:

The media should provide fast, objective, and accurate information and communications before to, during, and subsequent to a flood event. This approach will facilitate the implementation of efficient strategies for preserving human lives, mitigating property destruction, enhancing public awareness, and empowering individuals to adopt proactive and pragmatic measures for safeguarding themselves from floods. In order to enhance the efficacy of reporting on flood and associated calamities, it is imperative to provide reporters with training on modern methodologies for disaster coverage. The inclusion of such training and its corresponding institutions is vital inside the Mass Communication departments of Nigerian universities. This activity will facilitate students' familiarity with techniques for reporting natural catastrophes such as floods. It is imperative for the media to actively discourage subjectivity and refrain from adopting a negative stance while reporting on national concerns such as floods. The code of ethics for journalists should serve as the guiding principle for the press.

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ROLE OF THE MEDIA AND DEVELOPMENT COMMUNICATION IN PROMOTING SUSTAINABLE DEVELOPMENT IN NIGERIA

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ABSTRACT

The requirement for sustainable progress, particularly in developing nations like Nigeria, has brought about a renewed focus on effective communication and media coverage of developmental news. Development communication stands as a crucial element in any developmental endeavour, recognised as a powerful instrument for instigating reforms within a society. The primary function of communication in fostering development is to steer individuals towards comprehensive understanding of necessities, prevailing conditions, and the viable avenues for instigating change. This study thus adopted a conceptual framework to deepen the comprehension that knowledge and information are fundamental for people to react positively and effectively to the opportunities and challenges inherent in social, economic, and technological transformations within any society. However, existing literature indicates that the Nigerian media has consistently prioritised politics and sensational news, thereby allocating minimal attention to developmental issues. Hence, the necessity for the Nigerian media to highlight developmental news becomes a focal point of this study. This research delves into the roles, challenges, and opportunities of development communication and the media in disseminating developmental news within society. It recommends that messages in development communication campaigns should be formulated to induce behavioural change, employing an appropriate mix of media to effectively convey these messages. (Word Count: 200).

Keywords: Sustainable development, Development news, Development communication, Mass media

Introduction

Development communication is the deliberate use of communication strategies to address societal challenges in evolving societies. It revolves around the fundamental question of how communication either hinders or promotes social change. Communication plays a crucial role in any sustainable plan or strategy, serving vital functions both within and outside an organisation. Internally, individuals must articulate their thoughts and ideas to facilitate the creation of sustainable plans. Once internal communication is complete, external expression becomes equally essential. To effectively plan and implement sustainable strategies, individuals must engage in expressive communication, employing appropriate communication models (Genc, 2017).

According to Ojenike, Adedokun, Odunsi, and Ojenike (2014), the imperative for sustainable development, particularly in developing nations, has underscored the importance of revisiting effective communication strategies. Sustainable development aims for tangible enhancements and transformations in the quality of human life while preserving the vitality and diversity of communities. In the context of sustainable national development, communication serves a fundamental role by steering individuals toward a comprehensive understanding of needs, circumstances, and available avenues for change (Fraser & Restrepo-Estrada, 1998). Moreover, communication assists citizens in acquiring pertinent skills crucial for enhancing individual and societal conditions, contributing to sustainable national development. Recognising the pivotal role of communication in development underscores the necessity to grasp the fundamentals of communication strategy (Ojenike et al., 2014).

Conceptualising Development and Development Communication

Development communication, also known as DevCom or communication for development (C4D), involves the incorporation of strategic communication into development initiatives. Given that development inherently involves inducing behavioural changes, the utilisation of strategic communication emerges as a potent tool to enhance the likelihood of success in these projects. The focus extends beyond mere information dissemination, education, or raising awareness, as emphasised by Esimokha (2011). Although these elements are essential components of communication, they fall short in prompting individuals to alter deeply ingrained practices or behaviours.

Effective communication involves conveying information to specific audiences, attentively considering their feedback, and responding appropriately. Whether addressing a project's progress or broader economic changes, the goal is to foster consensus by enhancing public understanding and encouraging informed dialogue among stakeholders. The media assumes a pivotal role in disseminating developmental news and advocating for stakeholders. Research in communication suggests that the media can contribute significantly to national development (Schramm, 1964). Consequently, in developed nations, the media is granted a central role in shaping and sustaining the country. However, this dynamic appears different in developing countries, where evident poverty persists. This prompts an inquiry into whether

development communication is being implemented in Africa as it should be. Furthermore, it raises the question of whether the application of development media theory could serve as a remedy for the underdevelopment observed in developing nations.

The impact of development news on individuals' lives is widely perceived as positive, with the belief that exposure to such information benefits the majority. This perspective has sparked debates, prompting scholars like Aggarwalla (1979) and Moemeka (2000) to advocate for increased inclusion of development news in newspapers. However, a noteworthy observation is that development news receives limited attention in newspapers, particularly in comparison to sensational and political stories. Even when covered, development stories often lack critical reporting and analysis essential for the improvement of the target audience. This paper aims to critically evaluate the role of strategic communication and mass media in fostering sustainable socio-economic growth and development in Nigeria.

The concept of development has been subject to varied interpretations and theories by scholars. It can be characterised as an evolutionary process wherein human capacity grows, enabling the initiation of new structures and coping with challenges. Amodu (2007) defines development as a positive socio-economic change aiming to enhance the quality of human existence, elevate living standards, and uphold human dignity. Todaro and Smith (2003) elaborate on development as a multi-dimensional process involving significant changes in social structures, popular attitudes, national institutions, economic growth acceleration, inequality reduction, and poverty eradication. Soola (2003) emphasises that development should be inclusive, benefiting all strata of society and addressing the plight of the most impoverished individuals, lifting them from poverty, ignorance, disease, and human rights abuses.

Similarly, the concept of development communication (DevCom) has garnered considerable attention, leading to various definitions. Moemeka (1991) characterises development communication as the application of communication processes to facilitate development, implying the use of principles and practices of idea exchange to achieve development objectives. Quebral, who coined the term in 1972, defines development communication as

the art and science of human communication applied to speedy transformation of a country and the mass of its people from a state of poverty to a more dynamic state of economic growth, enabling greater social equality and the larger fulfillment of human potentials (Quebral, 1975). Bafo (2006) views development communication as the intentional and systematic utilisation of communication resources, channels, approaches, and strategies to support socio-economic, political, and cultural development goals.

Mefalopulos and Grenna (1998) define Development Communication (DevCom) as a process centered around dialogue, involving the strategic application of communication approaches, methods, and technologies to bring about social change. This definition highlights three essential features of DevCom: it is a process, an analytical activity grounded in dialogue, and it seeks to achieve change. Consequently, for optimal effectiveness, DevCom should be implemented from the outset of development interventions, starting with the identification and assessment of priorities, rather than solely during the planning and implementation stages. Without a communication assessment at the beginning, the process may be flawed and may not truly qualify as DevCom (Mefalopulos&Grenna, 2005).

Mefalopulos and Grenna further classify the strategic communication process into three broad phases: Communication research (problem analysis), Communication design and implementation (problem-solving), and Communication monitoring and evaluation (solution assessment). These phases provide a macro-level understanding of development communication. In the initial phase, communication serves as an analytical tool, with listening and dialogue playing crucial roles in investigating and assessing the situation. In the second phase (problem-solving), communication is utilised to address and resolve the identified problems. The third phase involves the use of communication to scrutinise progress, monitor changes, and evaluate solutions.

The theory and practice of DevCom are continually evolving, adapting to various approaches and perspectives reflective of the diverse development contexts that the field encompasses. According to AnaetoandAnaeto (2010), DevCom is a process that focuses on key elements such as audience, behaviour and attitude change, messages, channels, evaluation, and linkages.

Understanding Sustainable Development

Having explored the notions of development and development communication, it is imperative at this point to delve into the idea of sustainable development (SD). Sustainable development has become a widely used term in contemporary development discussions (Mensah, 2019). Ukaga, Maser, and Reichenbach (2011) observed that sustainable development is now a prevalent paradigm, serving as the buzzword for international aid agencies, the vernacular of development planners, the central theme of conferences, academic papers, and the focus of activists.

Despite its widespread use and the significant attention it has garnered over the years, the concept remains ambiguous, prompting many individuals to seek clarification regarding its meaning and implications for development theory and practice. In an effort to move beyond mere sustainability rhetoric and pursue a more meaningful agenda for sustainable development, it is crucial to provide a precise definition of this concept and elucidate its key dimensions.

The Brundtland Commission defined the concept of sustainable development in 1987 as development that meets the present needs without jeopardizing the ability of future generations to meet their own needs. Viewed as an approach, sustainable development entails utilising resources in a manner that allows them to persist for the benefit of others (Mohieldin, 2017). Evers (2018) further links the concept to the guiding principle for achieving human development goals while simultaneously maintaining the capacity of natural systems to provide the resources and ecosystem services essential to the economy and society. Approached from this perspective, sustainable development aims to attain social progress, environmental balance, and economic growth (Gossling-Goidsmith, 2018; Zhai& Chang, 2019).

Effectively conveying the principles of sustainable development involves identifying key aspects of public interest. It entails illustrating the interconnections between issues that resonate with people, the economy, and the environment. This communication strategy

involves highlighting positive aspects and underscoring opportunities, ideas, and innovations conducive to a favorable future. The focus should be on promoting a clean environment that encompasses health, organic agriculture, eco-friendly housing, and transportation. Employing sound communication practices is crucial, which includes explaining relevant aspects to the public, illustrating concepts with real-life stories instead of abstract recommendations, and using straightforward language (Bucur& Petra, 2011).

The Media, Development Communication and National Development

As previously mentioned, DevCom recognises the influential role of communication in driving social development. It involves harnessing existing communication tools and relevant theories to formulate effective strategies for advancing society. DevCom aims to bring about positive changes—be they social, political, economic, moral, environmental, and more—by facilitating a meaningful exchange of crucial information that motivates people to take action.

Numerous sources, both in literature and empirical studies, highlight the significant impact of the media on the progress of national development in developing countries, as noted by Schramm in 1964. Media, encompassing various communication channels such as radio, TV, newspapers, and magazines (Esimokha, 2011), serves as a crucial component. Development journalism, within this context, seeks to leverage the media to inform, educate, and sensitize the public on issues that can liberate and empower society.

The media acts as a tool to contribute to the developmental goals of their respective countries. Furthermore, it is effectively employed to foster national unity, cultivate patriotism among citizens, promote political stability, and encourage national integration for the peaceful coexistence and stability of the government.

Domatob and Hall (1983, *p.* 11) concisely supported the aforementioned claim by asserting that "Development journalism faces a somewhat more challenging task; it aims to disseminate the message of patriotism and national unity with the goal of fostering new social values and a cohesive national sentiment."

Studies have shown that the media have become ubiquitous tools of modern existence. They are expected to elucidate, inform, and educate society on critical issues that impact the well-being and progress of the community. Over the years, the issue of development has emerged as a prominent focus for the media. Since the 1960s, proponents of modernisation theory, such as Schramm (1964), have emphasised the significance of the media in a nation's development process. Their arguments have served as the foundation for many of the principles on which development journalism is constructed.

Development journalism perceives development as an attainable goal through collaborative efforts between the media and the government to instill national consciousness and unity among the populace. The media is viewed as a partner to the government in advancing national development, functioning as an ally in the pursuit of the progress of the state.

Media Selection for Development Communication

Mohammed, Bello, and Fajenyo (2003) asserted that mass media can be defined as channels of communication through which mass communication can be effected. They are channels through which a large number of people can be reached. This encompasses various forms such as radio, television, the Internet, film, newspapers, books, and more. The mass media play a crucial role in development programmes for effective participation and social mobilisation. The DevCom process necessitates a strategic approach to media selection and utilisation, tailored to the specific context to bring about desired changes.

Following George's (1990) rationale, understanding the cultural landscape is imperative before designing a media campaign. This involves surveying the cultural fabric of the target audience to inform decisions on media choice. Therefore, a sound knowledge base is required, encompassing what is needed, the capabilities of each available medium, the complementary contributions of different media, the cost of message delivery through various channels, and, most importantly, the cultural characteristics of the intended recipients.

In the realm of DevCom, media can be broadly categorised into print and broadcast. Print materials incorporate text and images, including newspapers/magazines, posters, booklets,

and flip charts. Despite their inclination towards the educated elite minority, these print materials can be adapted, formatted, and packaged for development purposes. On the other hand, broadcast media encompass radio, television, film, the Internet, and other forms such as folk media, theatre, and video. It is noteworthy that while mainstream media plays a pivotal role in disseminating development messages, the advent of technology has expanded the landscape to include social media platforms, which now also serve as valuable tools for development campaigns.

The Media and Communication for Development in Nigeria context

Research conducted in Nigeria has revealed that the media falls short in contributing significantly to societal development, as outlined by development journalism and development media theory. In a study focused on the press and the challenges of rural development, specifically comparing the *Weekly Trust* and *GaskiyaTafiKwabo* newspapers in Nigeria, the study explored the extent of their coverage on development-oriented and non-development issues. The study also delved into the predominant areas of coverage in terms of rural and urban development-oriented topics by these two newspapers – with *Weekly Trust* being a private-owned newspaper and *GaskiyaTafiKwabo* being a State newspaper.

The findings of the study indicated that both newspapers provided insufficient coverage to development issues in comparison to the space dedicated to non-development news. Moreover, the research highlighted that the coverage of rural development news (25%) was notably less than the coverage of urban-oriented development reports (47%). Notably, *Weekly Trust* demonstrated a significantly higher emphasis on rural development events, constituting 94.5%, in contrast to *GaskiyaTafiKwabo's* meagre 5.3%.

Challenges of Communicating Development News

From the aforementioned discussion, it is evident that the media, serving as conduits for disseminating development-oriented news, encounter significant challenges and obstacles from political leaders and private interests in African nations. Despite these impediments affecting their performance and efficacy, journalists must persevere and not allow such hindrances to impede their work. The media function as the fourth estate within the societal

framework, necessitating their steadfastness in fulfilling their responsibilities when circumstances demand.

For the media to operate effectively, it is imperative that the state ensures their freedom, encompassing access to information. While the implementation of the Freedom of Information Act is a positive step, the media's inability to access crucial information due to the Act's poor execution poses a substantial constraint. One major challenge lies in the existence of numerous legislations, such as the Official Secrets Act, Evidence Act, and The Criminal Code in Nigeria, aimed at safeguarding government secrets. These laws, designed to curb the unrestricted flow of information, significantly impact the Act's effectiveness (Esimokha, 2016).

Moreover, the imperative for the survival of various mass media outlets compels some to prioritise sensational news over developmental content. Many media entities operate with profit-making motives and contribute to class domination. In essence, classical Marxists perceive the media as being manipulated to serve the interests of those controlling economic power, particularly the bourgeoisie in a capitalist context. The constant dissemination of the media owners' perspectives through mass media reinforces their dominance and substantially contributes to the perpetuation of inequality between the upper and lower classes (Lenin 1972).

Development news, often characterised as tedious and uninteresting, lacks the appeal to drive newspaper sales. In actuality, people generally show a preference for news unrelated to developmental issues. This sentiment is succinctly echoed by Campbell (2004), who asserts that global audiences tend to shy away from serious news media, leaning towards content with an entertainment element. When presented with a choice between entertainment-focused and 'serious' news, audiences frequently gravitate towards the former. Murdock and Golding (1973) shed light on the behaviour of the media, explaining that economic pressures on media outlets prompt them to select, present, and package information that is both exciting and entertaining to meet the demands of their information consumers.

This observation underscores the crucial issue of the financial sustainability of Nigerian media, currently grappling with the harsh reality of economic downturns affecting various organisations and individuals. To endure, media entities must offer content that resonates with their target audience's preferences. However, this is not the sole determinant of news content, as advertisers exert influence on the editorial direction of publications where their ads appear. Consequently, advertisers play a pivotal role in shaping the content featured in newspapers, radio, or TV broadcasts.

Herman and Chomsky (1999), cited by Campbell (2004), support the assertion that news organisations prioritize attracting audiences with purchasing power over the audience itself, allowing advertisers to influence news content more than audience interests or needs. Campbell (2004) further emphasises that even well-established news outlets can succumb to the pressures exerted by advertisers.

In the realm of development communication, professionals, scholars, and experts are urged to collaborate with grassroots individuals and communities, enabling them to actively engage in the political and economic processes of their societies. Melkote (2003) advocates for synchronisation in the content of newspapers and other communication media to facilitate this meaningful participation.

Moreover, the dominance of English language publications has excluded local artisans, farmers, and market women from accessing development information crucial to their lives. Salawu (2002) suggests that establishing indigenous language newspapers focused on development news is a positive step forward, catering to both literate and illiterate populations in rural and urban areas.

It seems apparent that attention is not given to the professional value and ideology which are known for the practice of development journalism. The reportage of what the media houses call 'development news' is mostly event-oriented. Event-oriented news is the news coverage that does not really have relevance on the lives of the people. They are routine news which is mostly disseminated to serve as a public relations booster for the different organisations of

government. Development news must be covered based on the positive impact that it will make on the lives of the recipient and not the sources of the news.

An unfortunate aspect is the standard of education of many journalists covering development news. Some lack orientation on what development news entails, limiting their potential for mobilisation. Consequently, journalists may develop definitions of development news that undermine the nation's development efforts.

The subjective nature of the definition given to development news is highlighted, with studies indicating that journalists often present government or private propaganda as development news. The essence of development news should lie in reflecting the genuine needs of the people and having a positive impact on their lives. Therefore, the context of development news should be easily understood and highly relevant to the local environment.

The significance attributed to development news by scholars has generated debate regarding its value. Ogan and Fair (1984) assert that the coverage of development news should be assessed based on its potential to meet the population's needs. They argue against considering government handouts with self-serving praises for economic and social accomplishments as true development. According to them, labeling favorable information from government public relations releases as 'development news' does not alter the underlying reality.

Insufficient funds often pose a challenge in implementing development communication programmes. Adequate funding is essential for both the planning and execution of such programmes. Consequently, a lack of funds may restrict the programme's scope, the target audience, and the media channels to be utilised.

Conclusion

The conclusion drawn in this paper underscores the imperative integration of communication and media elements into any successful country's development plan, necessitating careful planning. It advocates the linkage of communication activities and facilities with national development plans, emphasising the interrelation of communication with different segments of the development plan. The paper asserts that for a development programme to attain its objectives, effective communication is paramount, highlighting its role in inspiring,

motivating, sensitising, educating, and mobilising various stakeholders. The absence of such communication, regardless of the quality of a development programme's packaging, hinders its success.

The paper identifies effective communication as a crucial tool for driving societal reforms, influencing the attitudes, opinions, and behaviour of stakeholders. Additionally, it underscores the significance of the media in communicating development news, acknowledging the challenges they face while emphasising their responsibility to not be socially irresponsible to society. The role of the media in setting the agenda, framing public debates, and determining content is emphasised. Ultimately, the paper positions development communication and the media as critical components for achieving sustainable national development, likening them to essential elements providing the necessary support for the nation's journey from economic recession to prosperity.

Recommendations

The messaging strategy for the DevCom campaign should prioritise behaviour change over simply disseminating information or raising awareness. This approach is crucial for altering deeply ingrained practices or behaviours, emphasising a mediation process that fosters dialogue among different social groups to identify common interests and needs and agree on collective action.

Utilising a diverse mix of media—traditional, local, and modern—is essential for fostering cultural, social, and economic reform. It is imperative for the government to create an environment conducive to media operations and for newspapers to allocate significant space for reporting on development news, giving it greater prominence. Editors should prioritize development-related issues, allocate more space and airtime to them, and increase the use of visuals.

Media organisations should establish dedicated development desks responsible for comprehensive coverage of development matters. Continuous training and retraining of reporters on development reporting, focusing on capturing the human perspective and making development news engaging, are essential.

Additionally, establishing development-focused newspapers, as in the case with *Public Agenda*, a strictly development focused bi-weekly newspaper published in Ghana, would help monitor development policies and projects, with attention to both rural and urban areas.

The various media houses should strive to be socially responsible to people that they are meant to serve. Public interest should not be sacrificed for profitability. The primary goal for the continued existence of the mass media should be to make significant contribution to the development of the society that inhabits them.

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THE IMPACT OF MOBILE PHONE APPLICATIONS ON STUDENT'S PSYCHOLOGICAL (COGNITIVE PROCESSES) AND CURIOSITY BEHAVIOUR OF NUHU BAMALLI POLYTECHNIC ZARIA, KADUNA STATE

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ABSTRACT

Mobile phone applications (apps), has become a very important aid where ideas and knowledge can be communicated between Lecturers-to-Students and external world-to-students, which helps in improvement of academic and innovation performances within our tertiary institution. This paper is written to examine and explore the correlation of mobile phone applications on both student's psychological (cognitive processes) and curiosity behaviour. This study would examine the effectiveness and level of impact of mobile phone apps on student's academics. The total numbers of 50 questionnaires were considered in the statistical analysis using SPSS and Ms-Excel in the descriptive statistic, correlation analysis, and t-testing. The examined results show that mobile phone apps have high positive significant effect on the student's cognitive processes and positive impact on their curiosity level. The findings show that since students are stuck to their mobile phones, there is a need to develop and create our own educational apps, and technological website in our own national local language dialects for effect communication that will increase student academic performance and innovation mindset.

Keywords: Mobile Phone applications, Cognitive processes, Curiosity, academic activities

1.0 INTRODUCTION

Mobile phone technology is one of the progressing, accelerating and advancing technological developments in the world today. The technology has become a powerful instrument through which ideas, knowledge, information can be disseminated, with high tendency of influencing people characters and behaviors either positively or negatively, which is done through the use of different programs and apps developed on the mobile phone. This make the youths more vulnerable to the impact of mobile phone application technology.

In our country Nigeria as at 2022 has an estimated population at around 216.7 million (Sasu, 2023). With the estimate of 70% of the whole country population is under age 30 years, and 42% is under the age of 15years (Akinyemi, 2023). This clearly shows that youths have a significant figure in the development of this country. However most of these youths are

students where use of mobile phone is already part of their life. Therefore with proper use of the technology it can help in re-programming their psychological and curiosity behaviour towards any kind of development (technologically, economically, academically, and financially) by using appropriate program applications. Furthermore, in Nigeria education system, according to statista, 68% of Nigeria youth in 2020 had receives secondary education. And 17% pursued higher studies after secondary education, and from the data analysis above we can say only 17% are students of tertiary institution such as: universities, polytechnics, colleges of education and others. Also in the latest data by UNESCO there are 20 million non-school-going children in Nigeria (Zoe Talent Solution, 2023), so with the proliferation of mobile phone both tertiary students and non-school-going uses mobile applications in their day to day activities that have impact on their life. Therefore in this study we would focus on Nuhu Bamalli Polytechnic students which are part of the 17% to determining the trajectory correlation of mobile phone applications, on students psychological (cognitive processes and curiosity behaviour).

1.1 Statement of the Problem

The mobile phone technology is one of the gifts to mankind in the world today in respect to communication, information sharing and exchange of knowledge in which if properly used it will help in bringing advancement among the youth, but unfortunately there was high level of misuse of the technology that make students to have challenges with their academic activities such as:- (headaches, dizziness, visual and auditory impairment, loss of concentration, decreased memory, fatigue, and other discomfort symptoms)and mental health such as (interpersonal sensitivity, depression, hostility, paranoia, compulsion, anxiety, and mania) (Jiao, 2022).Other challenges faced are the effect of student's psychology (cognitive process) and curiosity level this make them giving more attention to non-academic profitable mobile apps that lead to laziness and poor performance academically.

1.2Research Questions

- i. What is the impact of mobile phone use on student's academic activities and mental health?
- ii. What is the psychological impact (i.e. cognitive processes) of mobile phone applications on dealing with the student's curiosity?

- iii. What is the relationship between cognitive load process and mobile phone apps mostly used (i.e. Social media apps, Research/informative app., and other.)

1.3 Aim and Objectives of the Study

The main aim of this paper is to study the trajectory impact of mobile phone applications on student's psychological (cognitive processes) and curiosity behaviour of Nuhu Bamalli Polytechnic Zaria, Kaduna state. The objectives are as follows:-

- i. To determine the impact of mobile phone use on student's academic activities and mental health
- ii. To examine the psychological impact (i.e. cognitive processes) of mobile phone applications on dealing with the students curiosity.
- iii. To examine the relationship between cognitive load process and mobile phone apps mostly use (i.e. Social media apps, Research/informative app., and other.)

1.4 Hypothesis

H₀ - Students' curiosity of using mobile phone have effect on their psychological (Cognitive process

H₁ –There is a relationship between cognitive load process and mobile phone apps mostly use.

1. 5 Significance of the Study

This study was carried out as an additional contribution to researches made on the impact of Mobile phone Applications has on our high institutions of learning with focus on Nuhu Bamalli Polytechnic students. It does so by considering the sample group of student's (between 18 – 40 years of age) this would help to determine the impact level and relationship between the psychology (cognitive processes) and curiosity behaviour of youth and how it can be trajectory as channel of innovation and academic advancement in our nation.

2.0 LITERATURE REVIEW

In this section we focus on the review of few research works and contributions made by other researchers on the significance, impact and implication of mobile phone and Smartphone technology. And also review of some concepts that will be used in the cause of this study.

2.1 Overview of Psychology

The word ‘psychology’ is derived from the Greek *psyche* (mind, soul or spirit) and *logos* (knowledge, discourse or study). Psychology is the ‘study of the mind (Gross, 2020). Psychology is defined as the scientific study of behavior and the mind it refers to actions and responses which can be directly observed, whereas the mind refers to internal states and processes: such as thoughts and feelings which cannot be seen directly, but must be inferred from observable, measurable responses (Passer, 2009). Psychology help in explaining human habits of thought that he/she acquire which comes as result of critical thinking. Critical thinking involves taking an active role in understanding the world around you, rather than merely receiving information, this implies life and society. Also critical thinking also means evaluating the validity of something presented to you as fact (Passer, 2009).

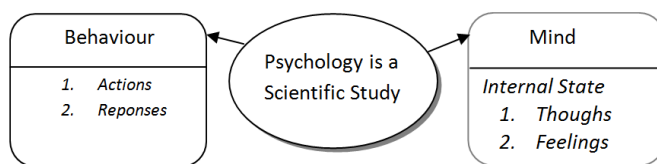


Figure 2.1: General view of Psychology

However, this paper would focus mostly on cognitive psychology. Cognitive psychology regards people as information processors that are being heavily influenced by ICT technology, human cognitive processes are compared to the operation of computer programs (analogy computer) (Gross, 2020). Cognitive psychology now forms part of cognitive science, which constitute the ‘cognitive revolution’, ‘memory tests or problem solving tasks’ provided they can be public. Consequently, what people say and do are perfectly acceptable sources of information about their cognitive processes; however, the processes themselves can be studied only indirectly (Gross, 2020). Therefore the cognitive processes include:-

Table 2.1: Cognitive processes in psychology

S/n	Cognitive processes
i.	Attention

- ii. Memory
- iii. Perception
- iv. Language
- v. Thinking
- vi. Problem-Solving
- vii. Decision-making
- iix. Reasoning and
- ix. Concept-formation

Source: (Gross, 2020)

Therefore, following this explanation of psychology and cognitive processes we can be able to establish the fact at mobile phone applications operations has impact on people behaviour.

2.2 Review of Research Works Contribution

According to (Lazaro, 2023) Technological revolutionary changes have boosted mobile learning's evolution from supplementary material for teaching to a flexible, strategic, and convenient resource, driving new paths in higher education all these was successful as the result of global increases in wireless internet access and the advent of highly functional Smart phones and tablets, which have impacted the rise in mobile device ownership, mobile learning has expanded its applications as a direct way to implement tailored learning settings and solicited tool in remote education. The result show: use of mobile phone embedded online higher education programs more simple by empowered interaction in content creation, communication, and collaboration between learners and instructors, significantly impacting learning effectiveness. It also gives pedagogic potential to educators. The research highlights future critical implications of using mobile devices pointing towards improving data literacy and skills, data security and protection against threats to personal privacy, and continuing

with the normalization of hybrid and remote learning settings, all these requires an economic investment. The researcher concludes by aim to focus future research on other critical technologies such as micro-credentials, open educational resources, XR and AI.

However, (Jiao1, 2022)show that Internet and everyday human life have a lot of intersections. And mobile phones were gradually occupied People's Daily life because the Internet is full of a large number of practical and ineffective information, and teenagers and children lack the mature ability to delete and select adequate information, and due to a scorching topic teenagers and children become Internet addicted. Therefore, the main research direction is whether mobile phone addiction will affect the learning ability of adolescents and children. The research works find both positive and negative correlations between mobile phone addiction and academic performance. Although cell phone addiction has a positive impact on life satisfaction, it has a negative impact on academic performance. After numerous studies, it remains unclear whether mobile phone addiction is beneficial to students' lives and whether it has a negative or positive impact on their academic performance. The researcher further explains that In the case of mobile phones, self-efficacy is associated with the perception of having confidence in using the technology that a user possesses. Students' intents cannot be changed by possessing mobile phones until and unless they are not intending to study, as intrinsic motivation is the most important factor in academic performance. According to the data gathered, despite constructively using many communication channels, students utilize them for amusement purposes, which leads to procrastination and can negatively impact academic performance. Overall, as previously indicated, the behavioral intention has a positive link with student academic performance, according to the data obtained. This research study would serve as a solid foundation for future studies.

3.0 METHODS AND PROCEDURES

3.1 Research Methods

The study adopted both quantitative and descriptive designs in carrying out data finding in the research. And qualitative design was use in the contextualizing to complement the quantitative data findings.

3.2 Context and Participants and Context

This study consisted of participants from National Diploma and Higher National Diploma students' of Nuhu Bamalli Polytechnic Zaria. And the contexts were as follows: - cognitive processes, curiosity level, cognitive load and mobile phone apps mostly used.

3.3 Sampling and Data Collection

In this study a simple random sampling method was used. A sample of 50 students whose age group ranged from 18-40 years, were randomly selected from different schools which are: School of Applied sciences, School of management studies, School of Engineering Technology and School of Environment Studies, in the two campuses. The data was gathered through the use of a hard printed questionnaire form.

3.4 Tools and Instrument of the Study

The following tools were used to achieve the objectives of the study. Rosenberg Self-esteem Scale, by Morris Rosenberg in 1965. It is a scale of total 10 items out of which five items are reversed scored. It is a four point likert scale format ranging from “strongly agree”, “agree”, “and disagree” to “strongly disagree”, scores are coded from 3 to 0 and the reversed items are scored from 0 to 3.

3.6 Reliability and Validity

Reliability and validation tests were conducted on the positive and negative impact of mobile phone usage on student's academic activities and mental health performance. This measurement helps in the representative set of items within the questionnaire. Concerning the instrument's validity MrKrishns Mohan of Amrita University constructs on the impact of a mobile on mental health were also tested on the students' of Nuhu Bamalli Polytechnic Zaria with emphasis to examine how it affect academic activities and mental health. Table 3.1 and Table 3.2: shown the reliability test conducted.

Table 3.1: The positive impact of mobile phone use on academic activities and mental health

	Construct	Reliability Statistics
1	Mobile phone can provide access to information and resources	

	that can help students in their academic activities and mental development by use appropriate apps.	Cronbach's Alpha
2	Mobile phone can help students stay connected with friends and family, which can provide social support and reduce feeling of hopelessness and isolation	Based on Standardized Items = .899
3	Mobile phone can provide mental stimulation through games, puzzles and other activities which can help keep the mind active and reduce the risk of cognitive decline.	Cronbach's Alpha = .446 N of Items 3

Table 3.2: The potential negative impact of mobile phone use academic activities and mental health

	Construct	Reliability Statistics
1	Excessive use of mobile phone can lead to addiction which may cause anxiety and depression	Cronbach's Alpha
2	The blue light emitted by mobile phone screens can interfere with sleep, which can lead to mood disorder, irritability and fatigue	Based on Standardized Items .991
3	Spending too much time on mobile phone can lead to social and academic isolation which can contribute to depression and anacity	Cronbach's Alpha = .947 N of Items

		3
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Cronbach Alpha analysis was used to measure the instrument's reliability. The result of the reliability coefficient indexes obtained showed that the Cronbach Alpha based on standardized item values for the positive impact of mobile phone (.899), negative impact of mobile phone use (.991), as shown reliable (Table 3.1 & 3.2). Hair, Anderson, Tatham, & Black (1998) stated that an alpha with more than 0.70 or higher values would be considered acceptable. Thus, this instrument has satisfied our study therefore it have fulfilled the essential requirement of validity and reliability in a survey study. This also explains the Physiological effects of mobile phone from the empirical study conducted by (Jiao, Yang 2022) capture in literature review 2.1.

- i. Therefore the result obtained from Cronbach Alpha analysis in table 3 & 4 shows that the first objective which stated "*To determine the impact of mobile phone use on student's academic activities and mental health*" has been achieved there students of Nuhu Bamalli Polytechnic agree that mobile phone apps have both positive and negative impact on their academic activities and mental health.

4.0 FINDINGS, RESULT AND DISCUSSION

Data Analysis was carried out using descriptive statistics with SPSS and Microsoft Excel package from the data obtained in the questionnaire distributed for the study

4.1 Findings

The demographic profile of the respondents as shown in Table 4.1 below:-

Table 4.1: Demographic profile of respondents

Demographic Profile		Frequenc y	Percentag e
Gender			

	Male	31	62
	Female	19	38
	Total	50	100
Age			
	18-25	29	58
	26-30	18	36
	31-35	3	6
	36-40	0	0
	41 and above	0	0
	Total	50	100
Programme			
	HND	35	70
	ND	15	30
	Total	50	100
School	Sch. of Applied Science	23	46

	Sch. of Engineering Technology	8	16
	Sch. of Environmental Studies	3	6
	Sch. of Management Studies	16	32
	Total	50	100

Source: Field survey, 2024

Table 4.2: Respondents response base on functionality, duration and apps mostly use

Variable		Frequency	Percentage
Functional mobile phone			
	Yes	49	98
	No	1	2
	Total	50	100
Mobile usage duration			
	1-3 years	3	6

	4-6 years	18	36
	7-9 years	11	22
	10 years and above	18	36
	Total	50	100
Apps mostly use on mobile			
	Social media apps	15	30
	Research/informative app	4	8
	Movies/Entertainment app	1	2
	All of the above	30	60
	Total	50	100

Source: Field survey, 2024.

Base on the demographic of the respondents shown on table 4.1, Male students participants mostly with (31, 63%, n=50) and Female with (19, 38%, n=50). Age range 18-25 (29, 58%, n=50) and 26-30 (18, 36%, n=50) this show active age of Nuhu Bamalli Polytechnic students. Table 4.2 shown that the student in the institution most of them use mobile phone duration 4-6 years and 10 years and above are (18, 36%, n=50) and 7-9 years (11, 22%, n=50) with mobile apps mostly use movies/entertainment apps (1, 2%, n=50), research/informative

apps (4, 8%, n=50), social media apps (15, 30%, n=50) and all of the above (30, 60%, n=50) as it graphically presented in figure 4.1 and figure 4.2.

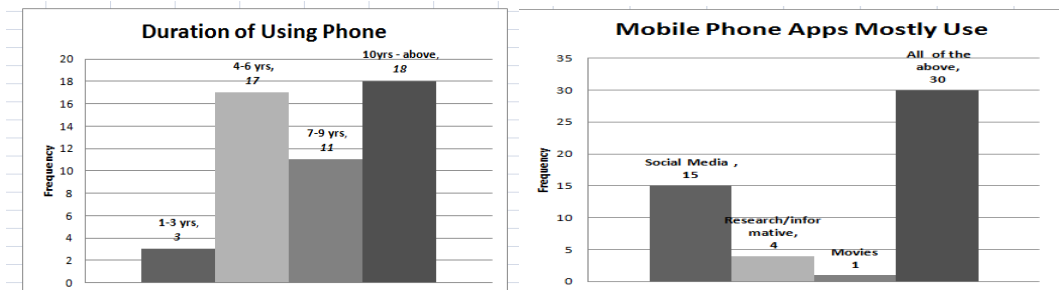


Fig. 4. 1: Duration of phone usage

Fig. 4.2: Mobile Phone apps mostly use

4.2 Result

a. Descriptive statistics was carried out on the dataset obtained from the questionnaire on the level of effect of mobile phone apps on student's psychology (cognitive process)

i. Based on **Research question 1a**: that stated "How can the psychological impacts (i.e. cognitive processes) of mobile phone applications. Firstly the analysis was done on the cognitive processes based on the respondents response by calculating the: mean statistics, mean standard error, standard deviation, variance, and kurtosis distribution as show in table 4.3 below:-

Table 4.3: Descriptive statistics of the effect of mobile phone apps on student's psychology (cognitive process)

	Construct	Very Good	Good	Bad	Very Bad
1	effect my "Attention" in learning and academic performance	21	19	10	0
2	effect my "Memory" in learning and academic performance	11	22	13	3

3	effect my “Perception” in learning and academic performance	13	17	16	3
4	effect my “Language” in learning and academic performance	21	12	13	3
5	effect my “Thinking” in learning and academic performance	14	14	17	3
6	effect my “Problem-Solving” in learning and academic performance	15	21	9	4
7	effect my “Decision-making” in learning and academic performance	24	10	13	3
8	effect my “Reasoning” in learning and academic performance	18	17	12	3
9	effect my “Concept-formation” in learning and academic performance	13	23	10	4
Mean stat		16.67	17.22	12.5 6	2.89
Mean std Error		1.500	1.507	.899	.389
Std Deviation		4.500	4.522	2.69 8	1.16 7

Variance

20.25	20.44	7.27	1.36
0	4	8	1
-	-	-.646	5.94
1.272	1.097		0

Kurtosis

From the result obtained using variables of cognitive processes were (mean statistics =16.67, Standard deviation= 4.5, variance=20.250 and kurtosis= -1.272) for very good response, and (mean statistics =17.22, Standard deviation= 4.522, variance=20.444 and kurtosis= -1.097) for good response. This show high significance levels that Mobile Phone/Smartphone due has positive effect on the students of Nuhu Bamalli Polytechnic. But also from the value obtained from Bad response (mean statistics =12.56, Standard deviation= 2.698, variance= 7.278 and kurtosis= -.646) shown it also has negative effect on the student likewise. Therefore from our examination the mobile phone have both positive and negative effect on the students.

- ii. Based on **Research question 1b.** that stated “How does it deal with the student’s curiosity. Secondly the analysis was done on the students curiosity based on the respondents response by calculating the: mean statistics, mean standard error, standard deviation, variance, and kurtosis distribution as show in table 4.4below:-

Table 4.4: Descriptive statistics on the use of mobile phone apps on students Curiosity level

	Construct	Strongly Agree	Agree	Disagree	Strongly Disagree
1	I want to know more when I am using mobile phone apps	27	21	2	0
2	I am feeling puzzled anytime I am using mobile phone apps	7	23	17	3

3	I want things to make sense anytime I am using mobile apps	21	21	4	4
4	I am intrigued by what is happening through the use of mobile apps	13	26	7	3
5	I feel like asking questions about what is happening went using mobile apps.	22	21	4	3
6	Things feel incomplete without using mobile apps.	22	19	4	5
7	I feel like searching for answers anytime I am using mobile apps.	21	21	3	5
8	I want to explore possibilities through the use of my mobile apps.	27	15	6	2
9	My interest has been captured using mobile apps	23	19	5	3
Mean stat		20.33	20.67	5.78	3.11
Mean std Error		2.154	1.000	1.489	.512
Std Deviation		6.461	3.000	4.466	1.537
Variance		41.750	9.000	19.944	2.361
Kurtosis		1.347	1.663	6.308	1.256

From the result obtained using variables of cognitive processes were (mean statistics =20.33, Standard deviation= 6.461, variance=41.750.250 and kurtosis= 1.347) for “Strongly Agree” response, and (mean statistics =20.67, Standard deviation= 3.00, variance=9.00 and kurtosis= 1.663) for “Agree” response. This show that there is good significance level on student’s curiosity went using Mobile Phone/Smartphone. But also from the value obtained from

“Disagree” response (mean statistics =5.79, Standard deviation= 4.466, variance= 19.94 and kurtosis= 6.308) shown that some student do not agree it risen their curiosity.

iii. Based on the variable and the result obtained from the student’s cognitive processes and curiosity, a relation analysis was carry out to examining if there is a correlation between the curiosity and cognitive processes as shows in table 4.5 below:-

Table 4.5: The mobile apps effect on student’s cognitive processes and their curiosity level.

The relationship of Cognitive process to curiosity	Curiosity (Y)	Cognitive Process (X)
	Want to know more	attention
	Feeling puzzled	Memory
	Want things to make sense	Perception
	I am intrigued by what is happening	Language
	Feel like asking question	Thinking
	Feel incomplete without mobile phone	Problem-Solving
	feel like searching for answer	Decision-making
	want to explore possibilities	Reasoning
	Capturing more of my interest	Concept-formation

Curiosity level vs Cognitive Processes									
Y	48	30	42	39	43	41	42	42	42
X	40	33	30	33	28	36	34	35	36
Correlation		0.313068843							
T-Test		0.002397788							

The result obtained from the correlation (0.313) shows that there is a very weak linear association between the two continuous variables (curiosity and cognitive processes). It also shows that mobile phone apps affiliated them differently because they're both independent variables ascertains the degree of mobile phone apps in one dataset and doesn't depend on another. The low/weak correlation implies that the two datasets are pitifully related. To ascertain the correlation value the student's T-Test was carried out on the two datasets.

The value obtained from the T-Test (0.0024) confirms that two groups of datasets are different from each other because the T-Test degree of freedom ($df = n-1$) and the corresponding alpha value $\alpha = (0.05 \text{ or } 0.1)$ which is greater than the value of T-Test obtained statistically.

Therefore the null hypothesis " H_0 - Students' curiosity of using mobile phone apps has effect on their psychological (Cognitive process)".

The outcome of the result shows that the null hypothesis is wrong; there is no relationship effect of mobile phone apps on student's curiosity and cognitive processes; they're significantly different.

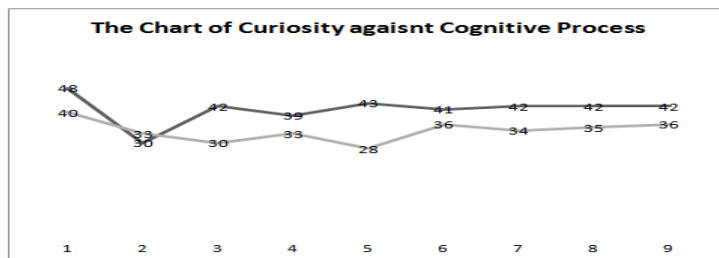


Fig. 4.3: The chart of curiosity level vs cognitive processes

iv. Therefore the second objective has been achieved which stated "*To examine the psychological impact (i.e. cognitive processes) of mobile phone applications on dealing with the students' curiosity*". From the correlation result obtained on table 4.6. Both student's cognitive processes and student's curiosity are independent variables dataset that operate differently on student's academic behavior.

b. Descriptive statistics was carried out on the dataset obtained from the questionnaire on the cognitive load process and applications mostly used by students.

i. Based on the third research question which stated “*What is the relationship between cognitive load process and mobile phone apps mostly used (i.e. Social media apps, Research/informative app., and other.),* the following analysis was carried out.

Table 4.7: The uses of Mobile phone applications (apps) in Cognitive Loading.

	Construct	SA	A	DA	SDA
1	The use of mobile apps technology improved my understanding of the content that was covered in my academic activities	29	17	3	0
2	The use of mobile apps technology improved my understanding of the problem that was/were covered in my academic activities	28	15	3	3
3	The use of mobile apps technology improved my knowledge of the terms that were mentioned in a certain subject/course taught in class	22	21	3	3
4	The use of mobile apps technology improved my knowledge of how to deal with the problem/s covered in a certain subject/course taught in class.	19	20	5	5
5	The use of mobile apps technology improved my understanding of how to deal with the problem/s covered in any course taught.	26	18	4	1
Mean stat		24.80	18.20	3.60	2.40

Mean std Error	1.881	1.068	.400	.872
Std Deviation	4.207	2.387	.894	1.949
Variance	17.700	5.700	.800	3.800
Kurtosis	-1.571	- 1.117	.312	-.817

From the result obtained using variables of cognitive load processes were (mean statistics =24.80, Standard deviation= 4.207, variance= 17.700 and kurtosis= -1.571) for “Strongly Agree” response, and (mean statistics =18.20, Standard deviation= 2.39, variance= 5.70 and kurtosis= -1.117) for “Agree” response. This show that there is good significant level on student’s cognitive load processes when using Mobile Phone/Smartphone. While the value obtained from both “disagree and strongly disagree” is less significance

However correlation analysis test was carryout on both the mobile phone applications mostly use and the cognitive load processes to ascertain if there is relationship between the student’s mostly use and their cognitive load processes.

Table 4.8: The applications mostly use and cognitive loading

Variable	Mobile Phone Apps (Y)	Cognitive load processes (X)
the relationship between Mobile Phone apps to cognitive load Processes	Social	improved my content understand
	Research	improved my understand in problem
	Movies	improved my knowledge in class
	All of the above	improved my understand on deal with subject

	improved my understand on deal with
none of the above	problem

Mobile Apps vs Cognitive Processes					
Y	15	4	1	30	0
X	17	15	21	20	18
Correlation		0.214900987			
T-Test		0.192743304			

The result obtained from the correlation (0.22) shows that there is a very weak linear association between the two continuous variables (cognitive load processes and mobile apps mostly use). To ascertain the correlation value the student's T-Test was carried out on the two dataset. The value getting from the T-Test (0.2) confirm that one group of dataset have determining effect on the other dataset, base on the corresponding alpha value $\alpha = (0.05 \text{ or } 0.1)$ which is less than the value of T-Test obtained statistically.

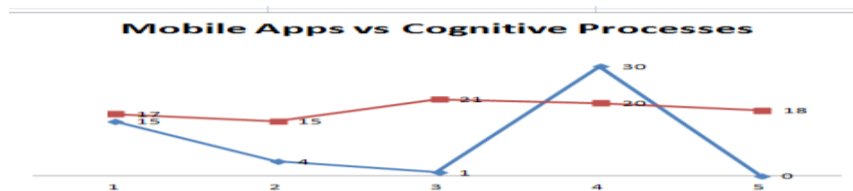


Fig. 4.4: The mobile apps vs cognitive loading

ii. The third objective has been achieve which stated “To examine the relationship between cognitive load process and mobile phone apps mostly used (i.e. Social media apps, Research/informative app., and other.)”. Form the correlation result obtained on table 4.8. There is very weak relationship between student's cognitive load processes and student's mobile apps mostly used. But the T-Test shows that one dataset have determining effect on the other dataset.

4.3 Discussion

Mobile phone app is in fact now one of the powerful tools in the hand of our students and the youths in the country at large as it can be seen from the study. According to the descriptive statistics analysis result obtained from the effect of cognitive processes and curiosity in table 4.3 and table 4.4, the result shows high significant influence and impact on student's behaviour, the correlation results and student T-Test on table 4.5 and 4.8 the results show very weak relationship, that make mobile phone apps have impact on students cognitive processes, curiosity, and cognitive load independently. But mobile phone is now a very powerful learning and educational tools in the hands of students and youths at large in that can be used to acquire skills and knowledge with proper use of right applications.

Therefore mobile phone apps can function in the following ways:-

- a. Enhance tools: - it can help to enhance student's cognitive processes and curiosity level that can lead to better academic performance with proper use of good knowledge applications.
- b. Simplicity tools: - it can help for research of complexity principle, method and procedure and break it to component for better understand with proper use of research applications.
- c. Communication tools:- it can help in the communicating of new ideas, discoveries and finding between students-to-students and students –to-lecturer with the help of good educational applications.
- d. Innovation tools: it can help in the explanation and transforming science into technology.

In order to achieve the above functions, firstly there is a need to transform our tertiary curriculum to software apps that can be installed or download on mobile phone. Secondly more practical apps should be developed to help in changing the mindset of students to be more technological oriented which can lead to positive development in our society and country as large.

5.0 CONCLUSION

In fact mobile phone is now a useful tool in the hand of students and people at large with both negative and positive effect on their academic activities, mindset concentration and mental health which could be managed for the benefits of education with proper learning and

educational apps, in order to increase positivity among the students and youth at large in knowledge sharing, ideas exchange, skill acquisition, technological innovation and invention. Because from the study that was conducted on the students of Nuhu Bamalli Polytechnic Zaria it shows high significant effect on students' psychology (cognitive processes) and curiosity level, which help in defining students intelligent quotient that can lead to discoveries and development habit.

Therefore with proper curriculum and content analysis software apps in our tertiary institution can also serve and help as bedrock development and advancement in our school and the country as large.

RECOMMENDATION

It recommends that we have mobile phone applications in our own local dialect and languages across the entire curriculum taught in our school. As we can see most of these developed countries in the world use local dialect in their educational system.

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E-RECRUITMENT PROCESSES IN ACADEMIC LIBRARIES: POTENTIALS AND HINDRANCES

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INTRODUCTION

The modern administrative perspective is concerned with human capital as the main engine of the physical capital of enterprises. Librarianship is experiencing a labor gap between increasing demand for library and information science professionals and a declining supply of qualified individuals resulting in an increasing number of unsuccessful recruitment efforts. Abdullah and Othman (2016) emphasized that organisational success and performance is highly dependent on how well a company deals with its human resources selection and recruitments. With the rapid rise in information technology and electronic information resources, the demand for skilled library professionals is on the increase the discussion turns

to an examination of issues and themes and strategies for selection, recruitment, retention and the potential for evaluating the library workforce.

Recruitment to the profession will require the active participation of professional associations, library and information science programs, and individual libraries.

Technology in human capital recruitment is an aspect recognized to expand the way organisations recruit, communicate and evaluate staff performance. As pointed out by Richardson (1997), the very definition of what it means to be technology-compliant is evolving due to the explosion of information and technology. The development in the society's needs necessitated technological innovation in human resource management and made it a dynamic concept. Virkus (2003) confirmed that this evolving state mirrors the expanding information needs of society due to technological advancement. As the society depends on information, and because information is expanding at exponential rates due to technological involvement, it became germane for organisations to involve technologies in their activities and operations including staff recruitments.

In recent years, the world has witnessed an upsurge in globalisation where the economies of many countries are interlinking to promote foreign trade through technological advances and connectivity (Carnevale & Hatak, 2020). One of the criteria of success for organisations and institutions is measured by the extent to which the human element is taken care of. In particular, top managers are becoming more aware of the important role of human resources in the success of their organisations to achieve performance (Al-Hawary & Shdefat, 2016).

Thus, companies that cover different domains constantly compete to upgrade their performance by developing advantages to differentiate themselves from competitors (Oyemomi et al., 2016).

Hameed and Anwar (2018) explained that human resources are determined by selection process. In a related development, Anwar and Ghafoor (2017) revealed that creativity, markets, the ability to adapt technology, access to capital and the existence of large-enhancing scale as an important trait for today's highly competitive market success. Anwar (2017) asserted that selective hiring practices have a positive effect on organisational performance. The study also revealed that training practices and overall results are interconnected. Therefore, improving the efficiency of an organisation's workforce would not

only benefit the workers but also ensure that all of the organisation's stakeholders are provided for. Conclusively, human resource management has a strong association with the organisation's overall performance (Hanić and Jevtić, 2020).

Due to an increasing demand for highly qualified staff and high-quality employee services, along with the need to engage employees in strategic measures, it is necessary to identify and assess the implementation of technologies in academic libraries recruitment processes. This is because traditional, deliberate, and risk-averse recruitment processes lead to positions remaining open for long periods, opportunities lost as top prospects find other positions, and a reduction in the overall talent level of the organization. To be more competitive and effective in their recruitment and hiring processes, academic libraries must foster manageable internal solutions, look to other professions for effective hiring techniques and models, and employ innovative concepts.

Human Resources

Human resources are considered the most important asset of an organization, but very few organizations are able to fully harness its potential. Indeed, the HRM function in organizations has gained increasing strategic emphasis, and the importance of its alignment HR and business strategies is well-acknowledged. In fact, Hustad and Munkvold (2005) stated that effective HRM is vital in order to be able to meet the market demands with well-qualified employees at all times. Typical Human Resource programmes involve activities such as record keeping, recruiting, selection, training, employee relations, and compensation.

Human resources management is one of the departments dealing with human capital management through its various practices and strategies. The aim of these practices is to raise the level of performance of employees so that they can perform their functions fully (Islam et al., 2016). Companies and business organisations rely mainly on human resources, financial resources, and technological resources. Human resources are the most important resources, as these organisations still need the human element to produce goods and provide services to clients (DyKam, 2015). Despite the importance of the financial resources of an organisation, as well as the extent to which they use modern technology in its field of work, its success

depends primarily on the efficiency, enthusiasm and effectiveness of its employees (Hosain, 2016).

This upsurge has also fuelled the increased rivalry in the national and foreign markets that has further encouraged organisations in hiring and retaining highly talented workers. Therefore, they are strongly related to the efficiency of their human resources and their human resources management (Collins, 2021). Modern theoretical philosophy agrees that the human element needs to be taken care of; the reason is that this particular element is more important than all others related to business.

Organisational performance is the ability of an organisation to achieve a set of goals that lies at the heart of the organisation's survival and prosperity; these goals include increasing market share, retaining profit, and retaining a competitive edge. It focuses on sustaining long-term survival of an organisation, which depends on using appropriate strategies and action plans.

The search for peak performance is the fundamental goal of an organisation.

Recruitments in Academic Libraries

Academic libraries spend considerable amount of time on the hiring process. The average length of time for the hiring process is 41 days from the time the first candidate is interviewed to the time that the successful candidate is contacted. The average number of days between the interview with the first candidate and the last is 26 days. There is an average of 16 days after the interview with the last candidate before the successful candidate is contacted. In an extreme case, one library reported 281 days between interviewing the first candidate and notifying the unsuccessful candidates (Raschke, 2018). The above scenario highlighted some demerits of using the traditional system which include the amount of bureaucracy, procedural impediment, and general lack of expediency in the traditional search process, even though some librarians believed that the traditional method fortified consultative decision making, soliciting a breadth and range of opinions, promoting objective decision making, promoting participation among different constituencies, and allowing candidates to see a range of prospective colleagues and obtain a range of perspectives.

Recruitment refers to the process of attracting, screening, selecting, and on-boarding a qualified person for a job. At the strategic level it may involve the development of an

employer brand which includes an 'employee offering'. The stages of the recruitment process include: job analysis and developing a person specification; the sourcing of candidates by networking, advertising, or other search methods; matching candidates to job requirements and screening individuals using testing (skills or personality assessment); assessment of candidates' motivations and their fit with organisational requirements by interviewing and other assessment techniques. The recruitment process also includes the making and finalising of job offers and the induction and on-boarding of new employees. Depending on the size and culture of the organisation recruitment may be undertaken in-house by managers, human resource generalists and / or recruitment specialists.

Alternatively parts of all of the process might be undertaken by either public sector employment agencies, or commercial recruitment agencies, or specialist search consultancies (Jovanovic, 2004).

Recruitment is one of the essential functions of human resource management. Recruitment was simpler in old days -- people worked as a blacksmith, a peasant, or a doctor throughout their lives. As time went on, people became more diverse, knowledgeable, and skillful. They started to move on and change their occupations. Since then, recruitment has become more complicated for both job seekers and job recruiters (Harrisburg *et al*, 2020). Subsequently, Recruiters on the hiring end need to deal with information of many candidates just for one job, not to mention there are multiple job openings for just one company. With more information shared online, recruiters search for and identify the right candidates is analogous to finding the needles in the haystacks. The traditional recruiting process has changed dramatically recently by leveraging technology, such as social media, application tracking systems, and even Artificial Intelligence (AI) and block chain, to support talent recruitment. As many companies started to face recruiting challenges, they have incorporated e-hiring to their candidates' selection process. This type of e-recruiting has changed the corporate recruiting process thoroughly.

In agreement with the above, Samuel and Nyarko (2014) explained that Human Resources department representing 'recruiters' or "gate-keepers" have to make important decisions, including whom to target, what message to convey and how to staff recruitment efforts. If not done correctly, an organization's recruitment efforts can produce job applicants who are

unqualified, who lack diversity or who may decline job offers. These same applicants may be prone to turnover if hired. A poorly designed recruitment process can miss attractive job candidates including those who work for competitors because they never find out that a position is open.

Consequently, evaluating and hiring candidates are learned skills. Experienced decision-makers are often accustomed to traditional search processes. Any change or significant disruption of these processes may lead to alienation from the process and a lack of confidence in making quality choices. Mistakes in hiring can be painful and costly for any institution, but the benefits of a more efficient and aggressive process outweighed the occasional mistake. The modern academic library needs to reverse its major roles, moving from anticipatory to responsive in collecting materials and resources while moving from responsive to anticipatory in handling change, hiring and retaining personnel, and developing strategic goals. Academic libraries are entrenched in traditional hiring models when the tenets of traditional selection theory and practice remain rooted in an era of bureaucratic work organization, where stable, specialized jobs in large numbers were prevalent and which largely supported assumptions key to the paradigm

Using technology could be one of the answers to address this problem. As the talent market becomes more competitive and global, it is important to study the technology use in recruitment and staffing practices. For employers wishing to have a competitive advantage in the labor market, it is a necessity to adopt the advanced technology in recruitment. The use of technology in employee recruitment includes different practices and offers several advantages.

E-Recruitments In Academic Libraries

The rapidly growing number of information and communication technologies impacts the development and functioning of libraries ranging from library automation, robotics, AI, virtual reality (Chmielarz&Parys, 2018). This has impacted human resource management (HRM) styles in different ways. Recruitment has been undergoing a transformation to keep pace with economic changes and employee needs (Kaufman, 2014). The implementation of information technology (IT) solutions improves the provision of services for job candidates, employees and managers, and reduces administrative costs. In addition, the time spent by

human resource (HR) department employees on administrative tasks is reduced and the above-mentioned solutions enable them to undertake strategic activities related to employee management, empower managers through the development and support of their management skills and improve the talent management process (Bondarouk&Ruël, 2013).

E-Recruitment is the online attraction and identification of potential employees using corporate or commercial recruiting websites, electronic advertisements on other websites, or an arbitrary combination of these channels including optional methods such as remote interviews and assessments, smart online search agents or interactive communication tools between recruiter and applicant. E-Recruitment research does not focused not only on the attraction and identification of potential applicants; rather it covers the entire process of recruiting. E-Recruitment or e-Recruitment is the process of personnel recruitment using electronic resources, in particular the internet. Companies and recruitment agents have moved much of their recruitment process online so as to improve the speed by which candidates can be matched with live vacancies (Bondarouk et al., 2017).. Using database technologies, and online job advertising boards and search engines, employers can now fill posts in a fraction of the time previously possible. An online e-Recruitment system may potentially save the employer time as usually they can rate the e-Candidate and several persons in HR independently review e-candidates. Therefore, it is necessary to have tools that support the implementation of e-recruitment processes and provide data for the implementation of strategic activities. Integrating technology into human capital recruitment is also not as complicated as expected. Software and other recruiting tools are very easy to use. Technical support is also available most of the time. Technology tools have positive impact on the recruiting process.

In distinguishing between traditional recruitment processes and E-Recruitment, Raschke (2018) highlighted the following distinctions.

1. Large search committees	1. Small empowered search committees
	2. An efficient process
2. A deliberate process	3. Administrative support for moving quickly

	and aggressively
3. Bureaucratic impediments	4. Attracting and recruiting top candidates
	5. Moving quickly to identify, interview, and hire
4. Expecting large quantities of candidates	top candidates
	6. Flexible requirements
5. Expecting top candidates to wait for deliberate processes	7. Hiring for traits and potential as well as skills and experience
6. Excessive requirements and restrictions	8. Anticipatory
7. Hiring for existing skills and experience	9. Creating employability and promoting professional development training
8. Reactive	
9. Expecting loyalty and retention	

E-Recruitment Tools for Academic Libraries

It is pertinent to view how libraries can leverage on technologies to attract, develop and retain top talents and professionals into their domain. In doing so, the tools that can be used to achieve this purpose are important aspect of the discussion. Samuel and Nyarko (2014) also outlined ways in which these tools can be used for effective e-recruitment. According to the researchers, in the recruitment framework, the most representative IT tools are blogs, Online Social Networks, Virtual Worlds, Co-optation websites, Identity Management Websites, RSS feeds and Video Platforms:

Blogs: Blogs are personal editorial spaces that allow individuals to publish and distribute content easily. A great number of the blogs that can be seen are created by applicants and recruiters.

They use these spaces to broadcast their job offers and create their own “job blog”. For instance, Microsoft has developed blogs, such as Microsoftjobsblog.com for recruiting

purpose. Other forms of blogs are evolving, called « micro-blogs ». Micro-blog differs from a traditional blog because posts (*tweets*) are limited to 140 characters. The most famous example of a microblogging tool is Twitter now X. Tweets are displayed on the user's profile page and delivered to subscribers who are known as followers. Recruiters can use it to display job offers and source applicants. Job search engines for Twitter have even been created

Online Social Networks: These relationship platforms can be generalist such as Facebook and Myspace or specialized like LinkedIn or Viadeo (the two main professional platforms). Such sites make it possible to stay in touch with former friends and colleagues but also to find customers, suppliers, partners and future employees. Recruiters can do head hunting and contact “passive applicants” (Dekay, 2009). A recommendation system makes it possible to put one's profile to advantage with the comments of former employers.

Virtual Worlds

These are 3-D platforms, like SecondLife, where users create a character (“avatar”) and evolve in a world of virtual reality. It is a real place of expression that encourages the creation of communities. Virtual worlds offer a broad range of research opportunity.

Co-optation Websites: These websites, which are based on a network of people who are motivated (financially speaking) to find potential applicants within their entourage, are also a way of attracting new talents (the two French leaders are *Jobmeeters* and *Cooptin*). These platforms are showing greater confidence.

Identity Management Websites: These websites, such as *Ziki*, make it possible to improve your visibility on the internet by, for example, centralizing and synchronizing on one page: your blog, your social profiles... and by promoting your page through a Google commercial link.

RSS Feeds (Real Simple Syndication): This is a web feed format used to publish content. It makes it possible to follow in real-time different kinds of information contained on several web sites, for instance blogs. Updated information is automatically posted to your navigator, on a search engine of job offers (*Moovement.fr* for example), or on other Internet sites such as aggregators (*Netvibes* and *Google*). Applicants can select several RSS feeds and be informed about new job opportunities as they become available.

Video Platforms

These platforms, such as Youtube, Youjob or Zoom give companies the opportunity to present their work and job offers, and applicants the possibility of introducing their CV. Another use of video is to allow interviews by means of web cams during a meeting or an online specialized events.

Potential of E- Recruitment In Academic Libraries

Karasek(2019) explained somebenefits of infusing technologies in recruitment processes and they are:

Enabling communication and collaboration: IT is a tool for effective communication andcollaboration. E-mail, messaging, discussion lists, videoconferencing, virtual teams, electronic workgroups, and teleworking have changed the nature of workplace communication and collaboration. These make workplace interactions possible for employees even they are not physically present in the workplace (Benson *et al.*, 2002).IT improves the skills of workers for collaborating, accessing information and decision making (Tafti, 2009). Participative decision making becomes an organization-wide activity. Internet and web based technologies facilitate sharing of decision making responsibility through the organization hierarchy and structure (Benson et al., 2002). HRIS as an integrated system also increases the capacity of reporting in the organization (Dessler, 2008).

Competency Management: IT tools enable HR professionals both to reach larger candidate pool and make decision making more objective and effective to employ more relevant and competent candidates by means of decision making techniques in the selection and recruiting process. Improving and shortening the recruiting process increases competencies of incumbents and as a result quality of works. At the same time, because of distance access e-human resources can be used to develop human capital of the organization effectively (Lin, 2011).

Knowledge Management: Knowledge management is a systematic process of acquiring, creating, capturing, synthesizing, learning, and using information, insights, and experiences to enhance decision making (Ardichvili, 2002). Knowledge management system is a natural extension of HRIS and HR development activities (Hendrickson, 2003). HR professionals should integrate traditional HR functions into knowledge management (Hendrickson, 2003).

Because organizations should acquire and manage organizational knowledge to prevent knowledge loses when employees leave the job.

Cost decrease: Effects of IT on HR costs appear in several ways. Firstly, IT reduces costs of processes and works. For example, transforming from traditional HR to e-human resources reduces costs of some HR applications, such as, postal cost, announcement cost and data processing cost (Lin, 2011). Using self-service technology reduces the processing costs of HR up to 75%. E-selections and e-recruiting decrease costs of staffing and selections due to reduced employee turnover, reduced staffing costs, and increased hiring efficiency (Strohmeier, 2007). Secondly, using self-service HR allows employees to perform their own work themselves directly. Thus, Human Resources professionals spend less time on routine tasks (Baloh and Trkman, 2003).

Saving Time: IT allows HR professionals to spend less time on routine tasks (Gardner *et al.*, 2003) and make easier to acquire and analyze information (Bell *et al.*, 2003). For example, researches show that recruiting process shortens twelve days (Baloh & Trkman, 2003).

Increase in Efficiency: Intense use of IT aromatizes and standardizes routines. HR professionals may focus less on administrative activities and more on interpreting information. HR professionals may spend more time on other aspects of their jobs. Thus, HR professional can access more information, respond the problems in a timely major from managers and employees and evaluate the complex information more effectively (Gardner *et al.*, 2003).

It creates a manageable platform for job openings, attracts a lot more applicants through increased visibility on websites, collects and organizes hiring information effectively and efficiently, shortens the candidate screening and selection time, and helps to navigate ideal candidates with specific requirements. However, it also increases the total volume of job applications, which theoretically adds workload for human resource professionals. But due to overall improved effectiveness of the hiring process, the cumulative influence of e-recruiting still positive. In addition, it improves multiple stages of the staffing process. It changes the way of reviewing applications, communicating with candidates, scheduling interviews, and facilitating the sourcing process.

Hindrances to E-Recruitments In Academic Libraries

Judging by the culture of maintaining the status quo enshrined in most organisations' settings, academic libraries are not exception. Due to reliance on traditional search processes, partially on entrenched aspects of the academic culture and in institutional bureaucracy to adapt to current techniques. While each institution is unique and has its own systems and set of challenges, there is a multitude of difficult hiring scenarios with which libraries have become all too familiar (Raschke, 2018).

The Digital Divide is a term used to describe the disparities in access to ICT facilities such as telephones, personal computers (PCs), and the Internet across certain demographic groups. For this thesis effort, the Digital Divide will refer to disparity between the rich and the poor or the have and have not and perhaps Internet access, only.

These groups are those with lower incomes and education levels, certain minorities, and the unemployed) and using the IT (Internet) at higher rates to search for jobs or take courses is a challenge.

Internet includes problems in the infrastructure on which the network runs including insufficient bandwidth or under-capacity and lack of security (Brake & Lawrence, 2000). It is anticipated that infrastructure problems will be eliminated with implementation of new broadband telecommunication technologies including Digital Subscriber Link (DSL) and new mobile technologies by solving capacity problems on the network. DSL allows copper wires of old-fashioned fixed telecom networks to carry more than 10 times as much traffic. New mobile telecom technologies like Universal Mobile Telecommunication System will do the same for mobile networks, while high-capacity cable networks will offer yet another channel (Brake & Lawrence, 2000).

Inadequate funds/insufficient financial support undermined the adoption to full implementation of e-recruitment. Samuel and Nyarko (2014) also indicated the issues in e-recruitment include lack of staff; lack of budget; problems with time management; need to work with other departments; and lack of information technology (IT) support.

Panacea to Hindrances to E-Recruitments in Academic Libraries

Creating a culture that attracts top candidates and moves to identify and to hire them as efficiently as possible is of primary importance and also a supporting factor in improving academic library hiring methods and increasing talent within a library is recruitment.

Some academic libraries are successfully employing one established technique from the corporate world to attract and recruit talent: internships. Internships and residency programs attract talented graduates and give the hosting library an opportunity to develop and to retain exceptional librarians through permanent positions. Any library that makes the decision to provide and promote continuing technology education will reap the rewards of better hires, increased retention of qualified staff, and improved customer service.

Management of academic libraries should make adequate provisions for fund in order to ensure proper IT implementation and achieving the benefits of e-recruitment and seek advice on how to effectively carry cost effective e-recruitment implementation. Adequate infrastructure such as functional ICT facilities, technical training and development, internet facilities are made available.

Conclusion

The place of e-recruitments including selection, recruitment and development cannot be underestimated as they are getting significant in recent years. Academic libraries need to change their recruiting and hiring procedures to stay competitive in today's changing marketplace. By taking too long to find and to hire talented professionals in a tight labor market, academic libraries are losing out on top candidates and limiting their ability to become innovative and dynamic organizations. It is therefore pertinent for academic libraries in their recruitment processes to ensure that the skills necessary to succeed in their respective domains. The technological tools facilitate in-depth competence evaluation and retrieve candidate information from different sources to select the best candidates and they offer opportunities to broaden their knowledge, improve their skills and analytical capacities with the use of IT tools.

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THE STUDY OF A SELECTED PARKING FACILITY IN AKURE SOUTH LGAOdesanya J. Femi^a, Kanyio, A. Olufunto^b,^{a,b}Department of Logistics and Transport Technology, Federal University of Technology,
Akure, Ondo State. Nigeria^aEmail: jfodesanya@futa.edu.ng^a Corresponding Author**ABSTRACT**

Road automobile user's generally like to see that they are appropriately served when they intend to park their vehicles at any parking bar. However, that may not be so due to the fact that restrictions and undue parking may cause congestions and driving difficulties in high-density areas. This work study a selected parking lot in a high-density area in Akure South Local Government Area (LGA) (Arakale parking lot) of Ondo state using the conventional method. The parking data in the parking lot were collected at 15-minute intervals, and vehicles arrival and departure from the facilities were recorded using their plate numbers as means of identification for three days. While geospatial data, using satellite imageries were collected from secondary data which includes a set of three multispectral and multi-dated satellite imageries of the selected location. It was however deduced that the average parking volume for the parking facility was 335 vehicles. The average duration of parking was 14.56 min/veh. The average occupancy was 82.54%, The parking capacity was 2000 vehicle hours. The parking load was 201.5 vehicles per hour, the efficiency was 80.6%. However, the time spent get a free parking lot at peak period was a maximum of 17 minutes and the geo-spatial analyses showed the parking lot has a high number of vehicles parked at the time when the satellite imagery was obtained, justifying the data obtained from manual analyses. The study recommended that stricter law enforcement be carried out on on-street parking in the corridor of study.

Keywords: Parking, Capacity, Arrival Time, Departure Time

1.0 Introduction

In the field of city planning, parking is a crucial aspect considered by planners and traffic engineers. Various researchers around the world such as Dukiya (2021), Oyedepo & Afolayan (2016), and Spiliopoulou & Antoniou (2012) have extensively studied the analysis of parking facilities in city planning. On-street parking can impede traffic flow leading to congestion and increased travel time. Parking poses a significant challenge for traffic engineers and urban city planners globally as it plays a vital role in mitigating congestion and traffic management issues (Oyedepo & Afolayan, 2016). The management and control of parking rely on data for forecasting and predicting the availability of free spaces especially in high-density population areas like Central Business District (CBD). Smart Parking System (SPS) have been deployed worldwide to track and locate available free spaces (Fahim, Hasan, & Chowdhury, 2021; Idris, Leng, Noor, & Razak, 2009).

The causes of increase of vehicles in corridors around city centre is as a result of population growth and increase in standard of living which incentivize private car ownership (Janak, *et al.*, 2020; Shen, 1997). Several researchers have carried out various works on parking system with the most recent being on Smart Parking System (Fahim, *et al.*, 2021). In Europe, vehicular parking research has been carried out in various countries such as Spain and Dublin (Ireland) with studies by Watters, *et al.*, (2006) and Pons-Rigat, *et al.*, (2020) revealing the rate of trips terminating at reserved parking spaces for weekdays. Illegal parking is a common issue in most major cities worldwide with studies conducted in Greece by Spiliopoulou & Antoniou, (2012). In Asia, Janak, *et al.*, (2020) emphasize the importance of metrics like access to parking, parking charges, guidelines, and information system for managing and maintaining parking facilities. The study by Zu, *et al.*, (2014) suggest the need for more parking facilities in Wu Jiang district of China to address parking issues.

Research on parking management has been conducted in America and various parts of the world. In Africa, Gatesi, *et al.*, (2020) noted that the parking system in Nyarugenge sector, Kigali and Rwanda negatively impacts traffic due to the treatment of streets as both roadways and parking lots resulting in frequent traffic jams. The nature of parking services whether public or private depends on local city regulations.

In Nigeria, some researchers have employed Geo-spatial methods to analyse parking systems (Dukiya, 2021; Adedeji, *et al.*, 2018). Asiyanbola & Akinpelu, (2012) highlighted the problems caused by on-street parking in Nigerian cities where narrow roads and a lack of pedestrian lanes contribute to traffic chaos. The indiscriminate parking on road sides hinders smooth traffic flow. Oyedepo (2016) emphasized the significance of effective communication, parking enforcement, operational efficiency, and proper parking signage in addressing parking issues in Akure's central business district. Idris, *et al.*, (2009) conducted a review of smart parking technology emphasizing the role of vehicle detection sensors in creating reliable parking systems. Parking policies and management are crucial for urban mobility and mitigating negative impacts. Balancing car use and economic support in urban areas requires a well-crafted car parking policy. The importance of understanding parking demands and responses in various cities is stressed by Rye & Koglin (2014), this research

employs a number plate technique methodology to analyse the parking systems in Arakale parking lot located in Akure township. It estimates the parking index, capacity and parking load of the off-street parking facility. The work further discusses the study location, the road network system, methodology, arrival and departure pattern of automobiles and the efficiency of parking facilities.

2.0 Literature Review

2.1 Various Concept Reviewed for this work

This study will be based on conceptual review on various concepts such as concept of transport and development, the concept of infrastructure, concept of complete street and the concept of geospatial technology.

Concept of Transport and Development

The concept of transportation and development can be traced back to early civilizations when early researchers attempted to explain the relationship between spatial interactions and urban development. Specifically, Alexandra Von Humboldt (1836) and Carl Ritter (1831) elaborated on this concept. Edward Ullman (1954) is credited with pioneering the understanding of spatial interactions, highlighting the need for adequate parking facilities due to the movement of people and goods in urban areas. However, excessive vehicles seeking access to a location simultaneously often result in traffic congestion, exacerbating the parking problem (O'Flaherty, 2006). Oyesiku (2002) and Adedeji (2000) emphasized the crucial role of transportation in the socioeconomic and regional development of nations. Similarly, Odesanya (2021) pointed out that traffic flow is impeded by inadequate and dispersed parking facilities, leading to reduced Level of Service (LoS) for roadways due to insufficient parking.

Concept of Infrastructure

Infrastructure, a term derived from the French word "infra" meaning 'below,' and the term 'structure' denoting the arrangement and relationships of complex elements, is a broad concept (Cantu, 2017). Wanmali & Isam (1997) classify infrastructure as either hard (comprising large physical networks essential for economic activity and national functioning)

or soft (encompassing social, political, and cultural institutions and services supporting a community or nation, including health, education, commerce, housing, security, and defence), others categorize infrastructure as economic or social, with similar meanings. Oughton & Tyler (2013) further break down infrastructure into five sectors: telecommunications, transport, energy, water sanitation, and solid waste. Within each sector, there's significant heterogeneity. For instance, in transportation, sub-sectors like roads, airports, seaports, railways, and subways exhibit distinct costs, planning techniques, and maintenance requirements despite all falling under the umbrella of hard infrastructure. Similarly, the energy sector comprises various sub-sectors, including electric energy, hydro energy, gas, and oil. This relates to our research, as off-street parking facilities can be considered hard infrastructural traffic facilities

Concept of Geospatial Technology

Geospatial technology encompasses a wide range of tools used for collecting, analysing, and storing geographic information. It involves mapping geographic locations and assessing the impact of human activities (Cantu, 2017). One key component is the Geographic Information System (GIS) which employs digital software to combine data and maps related to socioeconomic trends and environmental events, producing layered maps for in-depth geospatial analysis (Wanmali& Isam, 1997). In addition to GIS, other forms of geospatial technology include geofencing, Global Positioning Systems (GPS), and remote sensing, all of which have numerous applications worldwide. Previously, geospatial systems were accessible primarily to large organizations, but they've become more affordable for smaller entities. Google Maps' launch in 2005 was a milestone moment, democratizing mapping technology. The origins of geospatial technology date back to 1832 when Charles Picquet created one of the earliest maps indicating the areas with a high concentration of cholera cases during a Paris outbreak. In 1854, John Snow improved on this work during a cholera outbreak in London by using spatial analysis to link cholera to contaminated water sources. Advancements continued with inventions like photozincography in the early 1900s, enabling separate layers for data representation on maps. The 1960s brought the development

of the Geographic Information System (GIS) concept by Roger Tomlinson, transforming traditional cartography.

The advent of satellites and computers in the mid-20th century revolutionized the science and art of photography interpretation and mapping, providing new ways to visualize data. Geospatial technology is an umbrella term for modern tools used in geographical mapping, analysis, and societal understanding, encompassing a broad range of applications (Pressbook, 2022). Space technology, which allows pinpointing the exact location of objects and people on Earth, has revolutionized various industries, from healthcare to banking and supply chain management (ESRI, 2022). Technologies like GPS, GIS, LIDAR, and aerial photography have seen significant advancements over the past two decades, leading to the development of various other tools (DOG, 2022; ArcGis, 2022). These technologies have found applications in predicting crop yields, monitoring plant health, and enabling real-time assessment for improved pasture management (ArcGis, 2022). Geographical Information Systems (GIS) have emerged as a necessity for spatial queries on geographical data, answering questions related to distance and object locations (SU, 2022). Geospatial technology includes various tools like Global Positioning Systems, Remote Sensing, and Geofencing, and it relies on data sources such as GPS data, satellite imagery, and geotagging (Collin, 2022).

2.2 Empirical Review

Numerous scholarly articles have extensively covered the intersection of geospatial technology and the transport industry. Notable works include those by: Asiyanbola& Akinpelu (2012), who pointed out that on-street parking is a significant issue in Nigerian cities, causing chaotic traffic due to narrow roads and insufficient off-street parking facilities. Oyedepo (2016) conducted a study around the central business district of Akure, identifying inadequate parking signage and enforcement as major issues and suggesting effective communication and parking enforcement as solutions. Idris et al. (2009) reviewed smart parking and technology, emphasizing the crucial role of vehicle detection sensors in creating a reliable parking system. Fahim et al. (2021) conducted a comprehensive analysis of smart parking systems, focusing on technological aspects, sensor usage, networking, user interface,

and computational approaches, providing insights into their suitability in various environmental conditions. Tscharaktschiew & Reimann (2021) delved into workplace parking, wage negotiation, income tax codes, and the adverse effects of parking, discussing socially optimal cash-out levels and resource costs for employer-provided parking. Rye and Koglin (2014) highlighted the importance of parking policy and management in urban mobility, recognizing the need for a balanced approach that addresses the negative impacts of car use while supporting the economy. They also listed parking problems and issues affecting policies in Table 1.

Table 1 Parking Problems and Some (Future) Solutions

Problem	Possible Solutions
Operational problems	Decriminalisation of parking enforcement, Creation of separate parking departments within city administrations, Digital parking payment and enforcement.
Externalities of parking	Self-enforcing measures (bollards, kerb build-outs) to deter obstructive parking, Controlled parking zones and improved enforcement, Parking guidance systems (static or real-time; linked to occupancy) to reduce parking search, Differential pricing to encourage the use of off-street and under-used, on-street parking, Park and ride coupled with management and higher pricing of city centre parking, Differential parking tariffs depending on environmental characteristics of vehicles.
Spatially concentrated demand	Differential pricing to encourage the use of off-street and under-used on-street parking, Improved publicity of existing under-used parking, Improve accessibility by other means of transport
Insufficient kerb space for residents' cars	Controlled parking zones and improved enforcement of Car clubs, Reduced parking standards for new non-residential developments, Limited or no availability of on-street parking permits, particularly for new residential developments.

Source: Rye & Koglin, (2014).

Nicholas & Lester (2009) proposed a comprehensive parking study, involving inventorying existing parking facilities, collecting data on parking accumulation, turnover, and duration, identifying parking generators, and gathering information on parking demand. Depending on the research scope, related factors such as financial, legal, and administrative

considerations may also be included. These studies collectively underscore the importance of geospatial analysis and data collection in addressing parking challenges in urban areas.

In the case of data collection, Information on turnover and duration are usually obtained by collecting data on a sample of parking spaces in a given block within 30 minutes for a 2 hours parking period. The turnover is therefore calculated using Equation 1 to 3.

$$T = \frac{V_p}{P_s} \quad 1$$

Where:

T is the turnover

V_p is the number of different vehicles parked

P_s is number of parked spaces

Analysis of parking data will further be carried out by getting relevant information about numbers and duration for vehicles legally parked, Number and duration for vehicles illegally parked, Space-hours of demand for parking and Supply of parking facilities. In other to obtain information on the first two, data obtained can be used to calculate parking space hours. The proposed formula for parking space-hour is given in Equation 2

$$D = \sum_{i=1}^N (t_i n_i) \quad 2$$

Where:

D is space vehicle-hours demand for a specific time

N is the number of classes of parking duration ranges

t_i is the mid-parking duration of the *i*th class

n_i is the number of vehicles parked for the *i*th duration range

Further in this study, the space-hours of supply can be obtained from Equation 2.3.

$$S = \sum_{i=1}^N (p_i) \quad 3$$

Where:

S is the practical number of space-hours of supply for a specific time

N is the number of parking spaces available

t_i is the total length of time in hours when the i th space can be legally parked during the specific period.

f is the efficiency factor

3.0 RESEARCH METHODOLOGY

This research design was based on the survey of traffic count and density of parked vehicles which are the major data that were collected for this study. Hourly traffic volume flow within selected corridors and off-street parking areas were also collected.

3.1 The Study Area

This research study area is Akure South Local Government Area (LGA) which is one of the two LGAs that constitute Akure city the capital of Ondo state. The study area lies between Latitude $7^{\circ} 4'$ and $7^{\circ} 25'$ North of the equator and between Longitude $5^{\circ} 5' 53''$ East of the Greenwich meridian. Ondo State is bounded in the North by Ekiti and Kogi States, in the East by Edo and Delta state and in the West by Osun and Ogun States. It is bounded in the southern part by Atlantic. The map of Nigeria presenting Ondo State, Map of Ondo State Showing Akure south, Map of Akure and Map of Network of Roads showing selected parking Lot is shown in Figure 1.

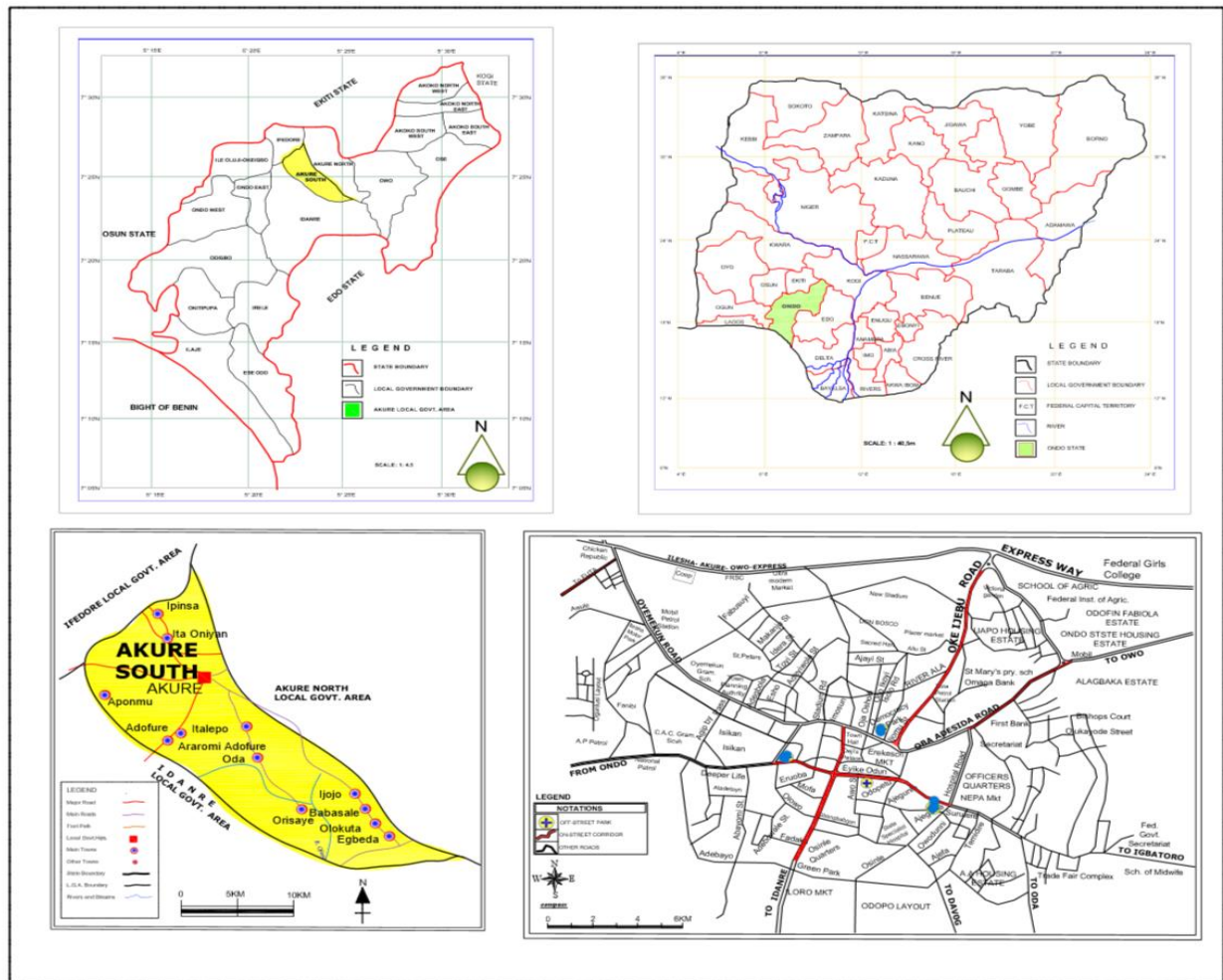


Figure 1: Map of Nigeria Showing Ondo State, Map of Ondo State Showing Akure south, Map of Akure and Map of Network of Roads showing selected parking Lot. Source: Researchers generated maps.

According to population census in 1991, the population of Akure Township was 239,124. By the year 2006 it has grown to 353,211 as reported by the National Population Commission (NPC, 2006). Using a projection growth rate of 2.5 the city's population was estimated to be around 476,785 in 2018. Akure serves as the capital of Ondo State, a role that carries significant influence within Nigeria which is attributed to its historical and cultural background. Ondo State is known for its growth and development in bitumen discovery and oil and gas producing influence.

Types and Sources of Geospatial Data

Secondary data included a set of three multispectral and multi-dated satellite imageries of the area spanning 1990 to 2000, 2010 to 2023 is used to highlight the geospatial parking pattern of the off-street parking. These imageries which include Landsat Thematic mapper (TM) (r191055/56) are acquired from the archive of the United States Geological Survey (USGS).

Arakale Parking Lot is the parking facility choose to be studied in this work. Length of corridor in Metres 307.71m and it is approximately, 3712.12m² square area of parking.

Parking Volume Count.

License plate identification method of survey was adopted in the enumeration survey, each parking stall was monitored at a regular interval of 15 minutes and the license plate number observed. This gives the data on the duration for which a vehicle stayed in the parking bay.

The parking duration of each parked vehicle was determined manually by trained enumerators using equation 1, the parking turnover is also calculated using equation 2 and finally, the parking index (Efficiency) is obtained by applying equation 3.

$$\text{Parking Duration} = \frac{\text{Number of vehicles parked} \times \text{Time interval}}{\text{Number of vehicles observed}} \quad 1$$

$$\text{Parking Turnover} = \frac{\text{Number of vehicles observed}}{\text{Number of vehicles parked} \times \text{Time interval}} \quad 2$$

$$\text{Parking Index (efficiency)} = \frac{\text{Number of vehicles observed}}{\text{Number of vehicles parked} \times \text{Time interval}} \times 100 \quad 3$$

4.0 Findings and Discussion

Arrival/departure data for Arakale Parking Lot.

Arakale Park is a very busy parking lot from the studied in this research. Table 2 presents the data for the Arrival and departure of Arakale Parking Lot.

Table 2: Parking Accumulation, Occupancy and Parking Load for the Arakale Parking Lot.

Time	Arrival	Departure	Accumulation	Occupancy	Parking Load
5	4	5	198	79.20	990
10	4	4	198	79.20	990
15	4	2	200	80.00	1000
20	4	2	202	80.80	1010
25	2	2	202	80.80	1010
30	4	3	203	81.20	1015
35	3	3	203	81.20	1015
40	3	3	203	81.20	1015
45	2	3	202	80.80	1010
50	4	2	204	81.60	1020
55	2	5	201	80.40	1005
60	5	4	202	80.80	1010
Total				967.2	12090

Source: Researchers field work (2023). Researchers Computations (2023).

It was observed that between 8:01 am to 9:30 am the facility recorded vehicles in double digits arrivals into the facility and an average of one vehicle departure, this could be attributed to most business owners around the facilities who own cars make use of this facility. And the location of these facilities is right in the heart of the city's busiest market. The standard carrying capacity for the facility is 250 vehicles. As at the time of data collection, an average of twenty-nine (29) vehicles were parked before the observations started and data were collected every 15 minutes. It was also observed that for the entire eight hours used to collect the data, most of the 15 minutes recorded a double-digit number of vehicles coming into the facility. The highest arrival period was recorded from 11:15 pm to 11:30 pm while the highest departure period was recorded around 4:15 pm to 4:45 pm. Table 4.6 shows that the Average Occupancy is 82.54%, the parking capacity is 2000 veh/hr for the 8 hours used in collecting the data, the parking load is 12090 veh/min or 201.5 veh/hr, while the parking efficiency is 80.60% showing that at the peak of the parking period only about 80.60% of the parking space is fully utilised.

Table 4.6: Parking Efficiency for Arakale Parking Lot

Parking Volume	Average duration	Average Occupancy	Parking Capacity	Parking Load	Efficiency
335 vehicles	14.56 min/vehicle	82.54%	2000 vehicle hours	12090 vehicle min or 201.5 vehicle hour	80.6%.

Source: Researchers Computations (2023).

In the final analysis, the parking facility experiences a significant number of vehicles arrivals during the observed time period, especially in the morning, possibly due to business owners in the vicinity and the prospective shoppers. The facility is located in the busiest market area of the city and this also contributes to the high demand for parking spaces at the parking facility. The high average occupancy rate of 82.54% indicates that the parking spaces are well utilized at a substantial level throughout the day. The parking load and efficiency figures suggested that the facility was effectively utilized, with a relatively high percentage of parking spaces being occupied during peak periods. The graphical representation of the arrival and departure pattern at Arakale Parking Lot is presented in Figure 2.

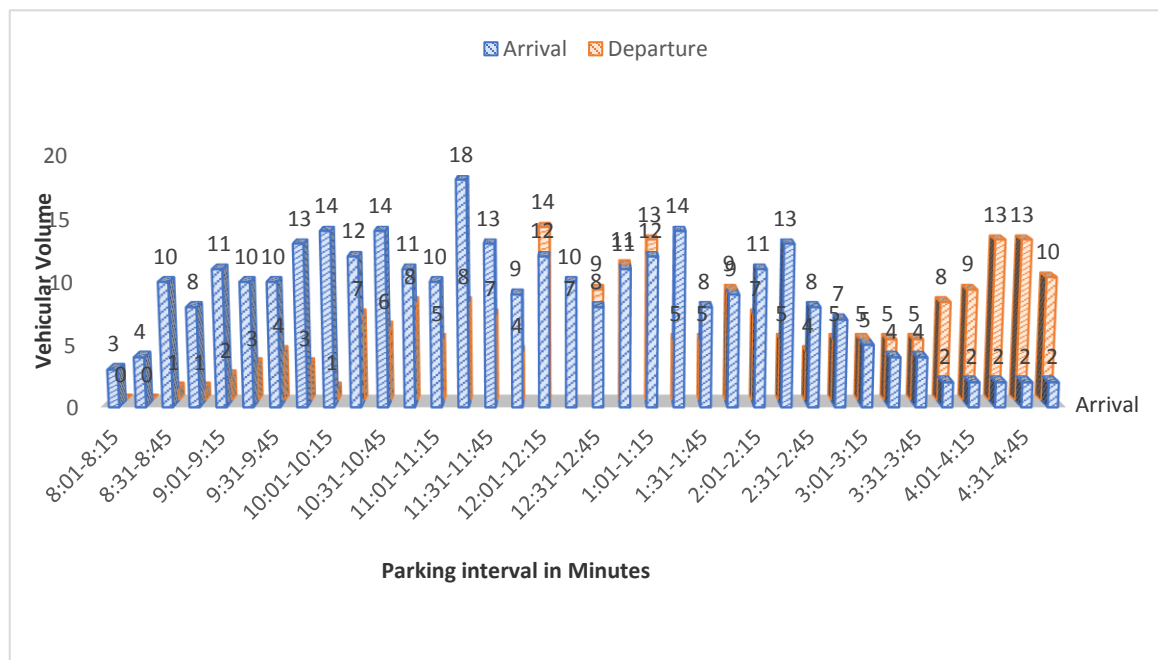


Figure 2: Vehicular Arrival and Departure at Arakale Parking Lot. Source: Researchers Analysis (2023).

Determination of the Time Spent Searching for Parking Space in the Study Location

The availability of parking space for motorists on a corridor is germane. This study also considered the time spent by motorists to get a parking space not too far from where they intend to do their business. However, the population density, availability of public transport and proper city planning will determine how well an area fares as it consigns parking.

The duration it takes for a vehicle to park at the facility in the morning is about a minute to park between 8.01 to 9.00 am. However, by 9:00 am to 9:15 am the parking lot begins to experience a gradual increase because of business activities. By 9:30 am to 10:30 am, vehicles coming to park in this facility experience a delay of 4 minutes which increased to 7 minutes, then to 8 minutes then to 10 minutes and a peak delay of up to 17 minutes. This gradual increase in the delay is due mainly to the rate of patronage of this parking facility. It was observed that the location of this facility at the city centre and very close to the main market of Akure. The main market of the town is situated a walking distance from this facility; hence most shoppers prefer to park in this facility to enable them shop easily around and trek back to their vehicles rather than park in the other lowly patronised park which is rather too far away from the main market. Figure 3 shows the parking duration for Arakale Parking Lot. The duration gradually reduces from 17 minutes to 16 minutes by 12:31 pm to 12:46 pm and the gradual decrease continues to 5 minutes at about 3:45 pm. The saturation of the vehicular and humans around this market are the major cause for the high parking duration experienced at this facility. The facility can only accommodate a maximum of 220 vehicles when fully filled and by 10:30 am the facility would have been almost full with few vehicles leaving the facility. As a result of this more vehicles would be queuing up for parking space within the facility. However, at about 3:45 pm more vehicles leave the park as shopping would have rounded up hence, more spaces are available for use at the park. Figure 3 shows the parking duration for the Arakale Parking lot.

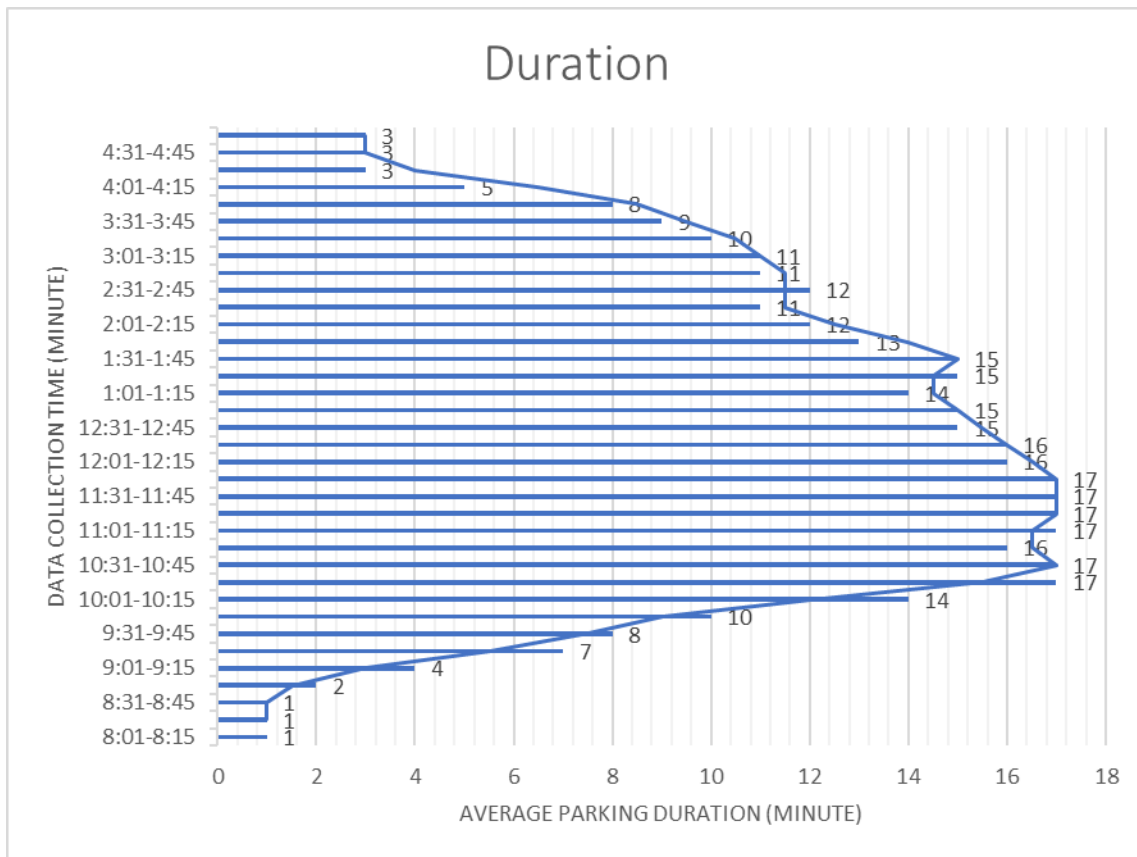


Figure 3. Parking Duration for Arakale Parking Lot. Source: Researchers Analysis (2023).

Geospatial Maps of the Study Locations Showing Level of Off-Street Parking

With the aid of a Geographical Information System (GIS), a geospatial map of the study location is developed to be able to access the volume of vehicles that will park in the selected parking facilities. The result obtained from each selected park is here by presented.

Geospatial Map for Arakale Parking Lot

The imagery of the facility is presented in Plate 1, the view displayed the number of vehicles parked in the parking facility in January, 2023 and from the data acquired, there are 176 cars in the parking lot. The facility tends to carry 250 vehicles at full capacity but at the time this data was collected, it could be seen that it carries only 176 vehicles in all.



Plate 1. Geospatial images of Arakale Parking Lot. Source: Landsat Thematic mapper (2023) ArcGis

5.0 Conclusion and Recommendation

Based on the analysis and discussion of results carried out, it was established that the Arakele parking lot examined for this study is well utilised and has above 80% efficiency utilisation. Furthermore, it was also discovered that more traffic movements are generated toward the parking facility and at peak periods, this is because of the increase in the number of people coming to the market which leads to an increase in the number of vehicles trying to park at the parking facility. This, however, leads to congestion along the corridor of study. This study has shown the ability to exploit the use of Landsat Thematic mapper (TM) (r191055/56), and satellite images to calculate the parking load and efficiency of a parking system if adequate imagery can be obtained.

Parking facility is essential in achieving suitable traffic control in Akure township, the researcher suggests the following recommendations: Regular measurement and analysis of traffic flow along road corridors should be encouraged by the ministry of transport in order to have adequate information to be able to combat the incessant high traffic flow observed around the road corridors leading to the off-street parking facility studied for this

work. On-street parking should be stopped around this facility to improve traffic flow in the area. Functional and effective public-mass transportation programme/schemes must be pursued with a high sense of commitment for implementation to reduce traffic volume around the corridor.

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OPTIMIZING INTERCITY PUBLIC TRANSPORT IN NIGER STATE: INSIGHTS FROM PASSENGER DEMOGRAPHICS AND TRAVEL BEHAVIOR

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ABSTRACT

The study investigates intercity traffic composition and the characteristics of public passenger transport in Niger State, Nigeria. Intercity transportation plays a vital role in shaping social and economic interactions, yet there is limited research specifically focused on Niger State, hindering the development of targeted policy measures. The study employs a survey methodology across nine major cities in Niger State, capturing diverse dynamics of intercity transportation and passenger demographics. Findings reveal significant gender imbalance among passengers, with males comprising a higher proportion (56.8%; 43.2%), and the majority falling within younger age brackets (85.2%). Students represent the largest occupational group (45.3%), emphasizing the importance of addressing the transportation needs of educational institutions. Household sizes and income levels vary, indicating disparities in access to transportation services. Moreover, trip origins and destinations highlight Minna's central role as a hub, with substantial traffic volumes (18,527 Trips) to other major cities like Bida and Suleja. Commercial motor parks dominate the landscape, reflecting a dynamic and competitive market environment. Understanding trip purposes reveals the multifaceted motivations driving intercity travel, with work-related trips (29%), education (38.8%), and business-related trips (34.4%) constituting significant proportions. These insights offer valuable guidance for transportation planning and policy formulation, emphasizing the need for tailored services to meet the diverse needs of passengers and optimize the efficiency of intercity transportation systems in Niger State. Addressing disparities in access, enhancing connectivity, and promoting sustainable transportation options are crucial steps towards fostering economic development and improving overall mobility within the region.

Key words: *Traffic, Intercity, Public, Passenger, Transport, Mobility & Accessibility*

1. Introduction

Transportation is essential to the functioning and survival of any society and economy as it influences the location and range of extended activities, it is also a vital quintessence of the multiple connections that exist between the physical environment, and patterns of social and economic development (Gbadamosi & Ibrahim, 2013). Consequently, it has been argued that transportation performs a vital function in human society with an overall contribution to the process of social and economic interaction because, to a large extent, the economic and social

development of nations is pivoted on the transportation system (Emmanuel, Jonathan & Otchere, 2013; Olorunfemi, 2020).

Mobility and accessibility provided by the public transport system have been playing a significant role in shaping countries, influencing the location of social and economic activity and the form and size of cities (Ojekunle, Akinola & Owoeye, 2018). An efficient public transportation system should be seen as a factor that unites the entire economy and facilitates development (Olorunfemi & Basorun, 2013). Intercity transportation in Nigeria has mainly been under the control of private operators who dictate largely the modes of operation in terms of facility provision, services, and standards in the industry. Consequently, such decisions are usually profit-driven and, most times, not totally in favour of the welfare of intended passengers.

1.2 Statement of Research Problem

The provision of efficient and accessible intercity public transport services is crucial for the socioeconomic development of Niger State, Nigeria (Adebayo & Ogunleye, 2020). However, the lack of reliable data and comprehensive understanding of the socioeconomic characteristics and travel behavior patterns of intercity public transport passengers has hindered effective planning and policy formulation in Niger State (Ogunleye & Adebayo, 2021). Without a detailed analysis of passenger demographics, trip purposes, modal preferences, and other key determinants of intercity travel demand, policymakers and transport providers are unable to tailor services that adequately meet the diverse needs of the population (Adebayo et al., 2019). This study aims to address this knowledge gap by examining the socioeconomic profile of intercity public transport users in Niger State and analyzing their travel patterns, with the goal of providing evidence-based insights to optimize the intercity public transport system and enhance mobility across the region (Ogunleye et al., 2022).

3. Literature Review

Intercity traffic composition and the characteristics of public passenger transport in Nigeria have been extensively studied by various scholars, providing valuable insights into the

dynamics of transportation systems in the country. Awoyemi, *et. al.* (2013) conducted an assessment of intra-urban mass transit operators in Ibadan metropolis, Nigeria, highlighting operational aspects within the city; Basorun & Rotowa (2012), focused on a regional assessment of public transport operations in Nigerian cities, particularly examining Lagos Island, contributing to the understanding of transportation systems in urban centers while, Eboli, & Mazuzulla, (2001), developed a methodology for evaluating transit service quality based on subjective and objective measures from passengers' perspectives, enhancing the understanding of service quality in public transport; Wole (2003), conducted a study modeling inter-urban road passenger traffic in Niger State, Nigeria, emphasizing factors influencing passenger traffic such as trip frequency, population, distance, and cost of transport

Raji, (2021) examined intercity commuting patterns using railway services in South-Western Nigeria, highlighting the influence of service improvements on passengers and the characteristics of intercity travelers in different transport units. While existing studies have illuminated various aspects of transportation across Nigeria, few have thoroughly explored the specifics of intercity travel within Niger State. Furthermore, some scholars have directed their attention towards understanding the dynamics of transportation in Niger State, Nigeria, particularly concerning intercity traffic composition and the attributes of public passenger transport. Orji et al. (2019) stressed the significance of developing sustainable pathways for intercity passenger transport, emphasizing the need to tailor research to the unique context of Nigeria, including factors like environmental sustainability and economic feasibility.

In a different context, Tang et al. (2019) conducted a case study on sustainable development pathways for intercity passenger transport in China, highlighting the importance of grasping the characteristics of intercity transportation to formulate effective policy measures. Similarly, Xiaowei et al. (2020) investigated intercity multimodal choice behavior in a touristy city, underscoring the necessity of analyzing travel patterns to enhance transportation planning and management strategies. These findings underscore the relevance of conducting similar investigations specific to Niger State's intercity traffic dynamics.

Moreover, Usanga *et al.* (2020) explored trip generation rates for residential land use in Uyo, Nigeria, indicating a broader interest in transportation research within the country. Nonetheless, there remains a noticeable gap in studies dedicated explicitly to intercity traffic composition and public passenger transport in Niger State. Addressing this gap could provide valuable insights into the region's transportation infrastructure, aiding policymakers and transportation authorities in making well-informed decisions. Therefore, conducting a comprehensive literature review on intercity traffic composition and the characteristics of public passenger transport in Niger State is essential to lay a robust foundation for future research endeavors in this domain.

4. Study Area

Niger State as shown in Figure 1 is one of the 36 States in Nigeria and the largest in landmass. The State covers 76,363 km². Niger State borders the Republic of Benin to the west, Kebbi and Zamfara States to the north, Kaduna and Federal City Territory (FCT) to the east, and Kogi and Kwara to the south. Niger state, a potential hotbed for economic activity, produces large quantities of rice, millet, maize and yam for local consumption and export. The state also has mineral deposits like gold, iron, copper, lead and columbite.

Niger State has many major urban centres, Minna (state capital), Bida, Suleja, Kontagora, Mokwa, Mashegu, Shiroro, Borgu and Lapai which are rapidly growing, putting tremendous strain on the ability of the state government to provide essential urban infrastructure services. The Nupe, Gbagyi, Kamuku, Kambari, Dukawa, Hausa and Koro form the majority of numerous indigenous tribes of Niger State. The state is named after the river Niger. It has an estimated population of 3,954,772 (NPC, 2006) and 6,584,982 projected in 2023 with annual growth rate of 3.71%.

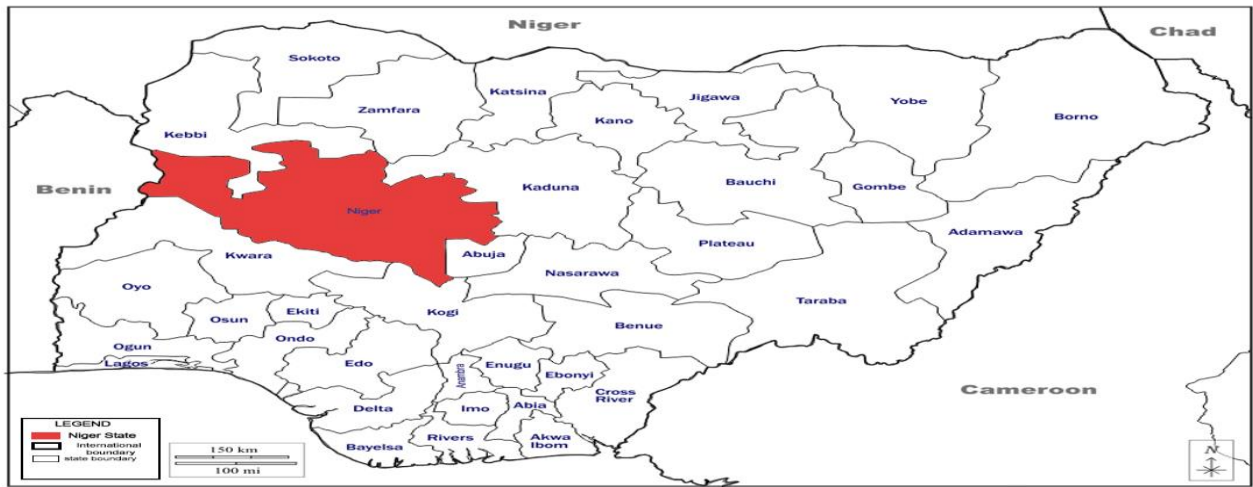


Figure 1: Nigeria in the Context of Niger State

Source: Niger State Ministry of Lands and Housing Minna, (2023)

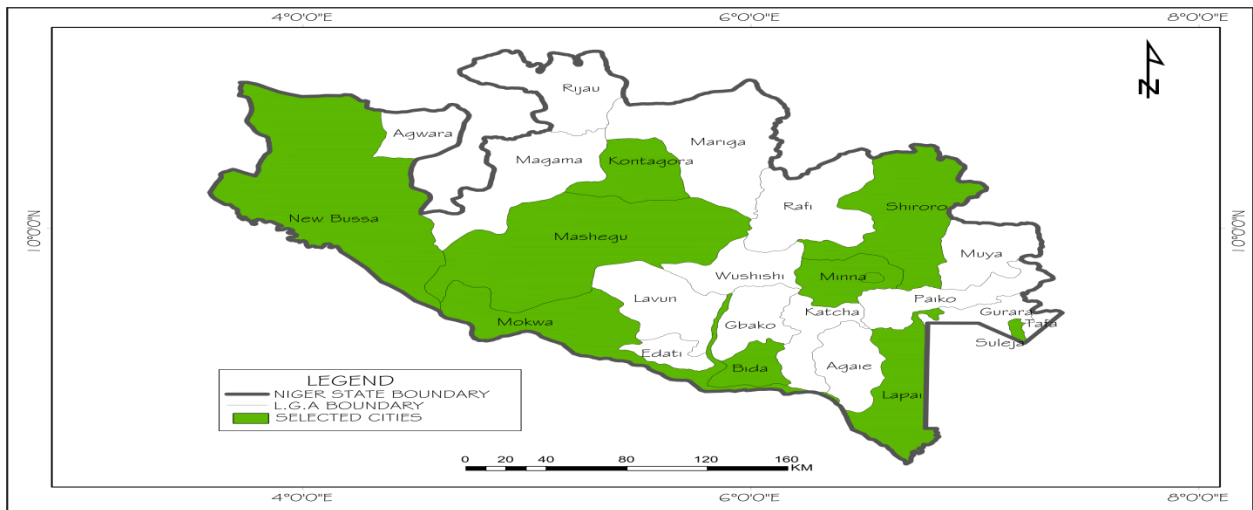


Figure: 2 Map of the Selected Study Area

Source: Author's Field work (2024)

Methodology

The research employed a survey methodology to examine the inter-city traffic patterns and passenger demographics of public transport in nine major cities across Niger State. The selection of these cities, as shown in Figure 2; Minna, Bida, Kontagora, Suleja, Mashegu, Mokwa, Shiroro, New Bussa, and Lapai, was based on criteria such as high population density, direct public transport links to the state capital, economic significance, transportation hub capacities, proximity to major cities, demographic diversity, well-developed

infrastructure facilitating accessibility, and organized intercity bus terminals. This strategic selection aimed to capture the diverse dynamics of intercity transportation in Niger State by encompassing both urban and rural areas to reflect varied travel behaviors associated with these distinctions. The survey method was utilized to gather data on traffic composition over a four-week period.

Additionally, data on traffic frequency and composition were obtained through volumetric traffic counts at designated parks during a four-week field survey in the selected cities, a total of 90,775 passengers utilized public transport services provided by both government-owned (Niger State Transport Authority - NSTA) and private operators. Specifically, 40,940 passengers opted for NSTA services while 49,835 passengers chose private operators. The study employed a systematic random sampling technique to ensure equal representation of commuters as respondents. Primary data collection involved administering structured questionnaires to passengers at selected garages to gather information on socioeconomic characteristics, origin-destination patterns, purpose of travel, and mode of transport. The sample size was determined using Dillman's formula to maintain a low margin of error in the study's findings.

The formula is given as;

$$N_s = \frac{(N_p)(p)(1-p)}{(N_p-1)\left(\frac{B}{C}\right)^2 + (p)(1-p)} \dots\dots\dots (1)$$

Where;

Ns = Complete sample size needed (notation often used is n)

Np = Size of population (notation often used is N)

P = Proportion expected to answer a certain way (50% Or 0.5 is most conservative) = 11,889

B = Acceptable level of sampling error (0.03) = (3%)

C = Z statistic associated with confidence interval (2.17) = 97% Confidence level

Source: Author's Field Survey (2024)

$$N_s \approx \frac{(90,775)(0.5)(1-0.5)}{(90,775-1)\left(\frac{0.03}{2.17}\right)^2 + (0.05)(1-0.5)}$$

Table 1: Population and Sample Size of Public Passengers

S/No	City	Names of Parks	Population of Passengers (Sample Frame)	Sample Size	Questionnaires Returned
1	Minna	Abdulsalam, Mobil & NSTA	18,527	263	255
2	Kontagora	Kontagora Central Park	10,162	145	141
3	Bida	Etsu Nupe Garage	10,267	146	139
4	Suleja	Old Garki Garage	10,637	151	148
5	Mokwa	Mokwa Garage	9,012	128	125
6	Mashegu	Mashegu Garage	5,832	83	83
7	Shiroro	Shiroro Garage	8,572	122	119
8	Lapai	Lapai Garage	8,891	126	98
9	New Bussa	Dantoro Garage	6,875	126	122
Total			90,775	1,290	1,230
$\approx \frac{(90,775)(0.25)}{(90,774)(0.000191)+(0.25)}$					
$\approx \frac{22,693.75}{17,587834}$					
$\approx 1,290$					

Table 1 provides details on the population and sample size of public passengers across various cities and parks within the study area. The population of passengers, representing the sample frame, is listed for each city's designated parks, along with the corresponding sample size selected for the study. For instance, in Minna, which has multiple parks including Abdulsalam, Mobil, and NSTA, total population of passengers' is 18,527, with a sample size of 263 selected for the study. Similarly, other cities such as Kontagora, Bida, Suleja, Mokwa, Mashegu, Shiroro, New Bussa, and Lapai exhibit varying populations of passengers at their respective parks, with sample sizes ranging from 146 to 83. Overall, the total population of passengers across all parks is 90,775, with a total sample size of 1,290 selected for the study. A total of 1,290 questionnaires were administered to the respondents out of which 1,230 were completely filled and returned valid. These statistics form the basis for understanding the demographics and behaviors of public passengers in the identified cities, aiding in the formulation of insights and recommendations for transportation planning and management.

4. Discussion and Findings

Table 2: Socio-economic Attributes of Passengers

Gender	Frequency	Percentage
Male	699	56.8
Female	531	43.2
Total	1230	100
Age of the passenger	Frequency	Percentage
15 - 25 years	574	46.7
26 - 35 years	282	22.9
36 - 45 years	192	15.6
46 - 55 years	94	7.6
Less than 15 years	58	4.7
Over 55 years	30	2.4
Total	1230	100
Marital Status	Frequency	Percentage
Single	754	61.3
Married	422	34.3
Widowed/Widower	20	1.6
Separated	18	1.5
Divorced	16	1.3
Total	1230	100
Occupation	Frequency	Percentage
Student	557	45.3
Self-employed	200	16.3
Trader/business owner	168	13.7
Civil servant	132	10.8
NYSC	46	3.8

Apprentice	43	3.5
Unemployed	29	2.4
Military/paramilitary	22	1.8
Artisan	19	1.6
Retired	8	0.7
Others	6	0.55
Total	1230	100
Household size	Frequency	%
4-6	355	28.4
1-3	333	27.1
6-8	348	28.3
Over 8	288	23.4
Total	1230	100
Income level of the Passengers per month	Frequency	Percentage (%)
Less than N30,000	394	32
N31,000 – N60,000	300	24.4
N61,000 –N90,000	204	16.6
N91,000 - N120,000	128	10.2
N121,000 - N150,000	80	6.5
N151,000 - N180,000	68	5.5
N181,000 – N210,000	44	3.6
Over N210,000	12	1.2
Total	1230	100
Education level of the Passengers	Frequency	Percentage (%)
Secondary	169	13.7
Tertiary	840	68.3

Primary	48	3.9
Informal	101	8.2
No education	73	5.9
Total	1230	100

Source: Author's Computation (2024)

Table 2 shows the socioeconomic characteristics of intercity public transport passengers in nine major cities in Niger State and unveils several key insights. Firstly, there is a notable gender imbalance with males comprising a higher proportion (56.6%) than females (43.4%). Secondly, the majority of passengers are in younger age brackets, with the 15-25 age group being the most prevalent (46.9%). Thirdly, a significant portion of passengers are single (61.46%), followed by married individuals (34.11%). Fourthly, students form the largest occupational group (45.4%), followed by self-employed individuals (16.3%) and traders/business owners (13.7%). Households typically consist of 4-6 individuals (28.4%). Lastly, a considerable number of passengers earn less than N30,000 per month (33.9%), with a majority having tertiary education (68.3%).

These findings have implications for transportation planning and policy formulation in Niger State. Understanding passenger demographics can aid in tailoring services to meet the needs of specific groups, such as young adults and students. Addressing the predominance of single passengers may necessitate flexible ticketing options, and initiatives to support student mobility could be beneficial. Strategies to address income disparities, particularly among lower earners, could improve equitable access to transportation services. Lastly, prioritizing accessible transportation options for educational institutions and promoting lifelong learning opportunities aligns with the emphasis on tertiary education. Overall, these findings provide valuable insights for policymakers aiming to develop inclusive and responsive transportation systems in Niger State.

The table provided offers insights into the socioeconomic characteristics of intercity public passenger transport in Niger State. The gender distribution shows that male passengers constitute 56.8% (699) of the total, while female passengers make up 43.2% (531). In terms

of age, the highest percentage of passengers are aged 15-25 years at 46.7%, followed by those aged 26-35 years at 22.9%. Regarding marital status, single passengers account for the majority at 61.3%, while married passengers make up 34.3%. The remaining percentages are widowed, separated, or divorced. When it comes to occupation, students are the largest group at 45.3%, followed by self-employed individuals at 16.3% and traders/business owners at 13.7%. Most passengers fall within the 4-6 or 6-8 household size categories. The income level data shows that the majority of passengers earn less than N30,000 per month, with a significant portion falling in the N31,000 - N60,000 income bracket. Finally, the education level of passengers indicates that tertiary education level passengers represent the highest percentage at 68.3%, followed by secondary education at 13.7%.

The policy implications for this findings include; public transport services in Niger State should be designed to cater to the diverse needs of its passengers. This includes providing more frequent services during peak hours and ensuring accessible and comfortable vehicles for male passengers (56.8%) and those aged 15-25 years (46.7%). Additionally, affordable and reliable services should be prioritized for single passengers (61.3%) and students (45.3%) to accommodate their schedules and ensure safe travel. Public transport services should also be designed to accommodate families and small groups, as most passengers fall within the 4-6 or 6-8 household size categories, and fares should be kept affordable for low-income households.

Comprehensive regional transportation planning is necessary to expand road capacity, improve public transport services, and keep travel costs low. Public transport services should be improved by ensuring well-maintained vehicles, frequent and reliable services, and affordable fares.

Table: 3 Traffic Volume of Public Passengers in Selected Cities in Niger State

TABLE 3 ORIGIN /DESTINATION MATRIX OF PASSENGERS TRIP

ORIGIN/DESTINATION	MINNA	BIDA	SULEJA	KONTAGORA	LAPAI	SHIRORO	MOKWA	MASHEGU	NEW BUSSA	TOTAL NUMBER OF TRIP
MINNA	0	3186	3883	3124	2484	1716	2304	1389	441	18527
BIDA	2230	0	1420	1202	1340	988	1617	783	687	10267
SULEJA	3581	1046	0	1038	1446	816	936	916	858	10637
KONTAGORA	2178	1556	1144	0	1568	1112	1134	783	687	10162
LAPAI	2001	1280	1190	1020	0	920	880	760	840	8891
SHIRORO	1954	1610	964	824	996	0	860	824	540	8572
MOKWA	1676	1502	1345	1139	1076	884	0	761	629	9012
MASHEGU	983	752	674	1006	710	516	489	0	702	5832
NEW BUSSA	1666	1005	882	1986	687	516	1104	1029	0	8875
TOTAL NUMBER OF TRIP	16,269	11,937	11,502	11,339	10,307	7,468	9,324	7,245	5,384	
GRAND TOTAL NUMBER OF TRIP										90,775

Source: Author's Computation (2024)

Table 3 illustrates an origin-destination matrix for intercity passenger trips within Niger State, showcasing travel patterns among major towns. Minna stands out as a key hub with the highest total number of trips (18,527), underscoring its central role in intercity travel. Prominent outbound trips from Minna are directed towards Suleja (3,883), Bida (3,186), and Kontagora (3,124), highlighting strong connectivity with these towns. This significant volume of trips originating from Minna points to a need for improved transportation infrastructure and services to manage high passenger numbers and facilitate efficient travel. Other towns also display distinct travel patterns, with Suleja, Bida, and Kontagora generating considerable trip numbers, reinforcing their importance in the regional transport network. For instance, Suleja has significant outbound travel to Minna (3,581) and Bida (1,046), while Kontagora shows substantial connectivity with Minna (2,178) and Bida (1,556). These travel distributions highlight the necessity for targeted transport policies to address specific route demands, such as enhancing road conditions, increasing service frequency, and potentially introducing direct routes to streamline passenger movement across the state. The overall high trip volume (90,775) indicates an active intercity transport system that requires ongoing development to meet growing demand and improve passenger travel experiences.

The findings suggests that transportation policies should focus on upgrading infrastructure and expanding services to accommodate the high volume of intercity trips, especially from key hubs like Minna. This includes enhancing road quality, increasing service frequency, and possibly adding direct routes to improve connectivity and efficiency. Targeted improvements

will help manage the substantial passenger flow, ensuring a reliable and efficient intercity transport system in Niger State.

Table 4: TRIP DISTANCE IN KM

S/NO	ORIGIN	MINNA	BIDA	LAPAI	SULEJA	MOKWA	KONTAGORA	SHIRORO	MASHEGU	NEW BUSSA
1	MINNA	34	89	70	106	217	195	68	240	319
2	BIDA	89	35.5	71	161	131	223	154	189	233
3	SULEJA	108	162	91	45.5	291	298	169	342	393
4	KONTAGORA	195	224	263	299	177	39.5	254	79	186
5	LAPAI	70	71	35.5	91	200	262	133	259	302
6	SHIRORO	68	154	133	169	282	253	34	297	385
7	MOKWA	216	131	200	291	51.5	177	282	117	103
8	MASHEGU	238	189	259	342	117	79	297	39.5	126
9	NEW BUSSA	318	233	302	393	103	186	385	126	51.5

Source: Author's Computation (2024)

The findings in Table 4 regarding trip distances within Niger State offer valuable insights into the generation of intercity trips and the patterns of public transport passengers. Notably, there is a significant variation in distances traveled between different origin-destination pairs, indicating diverse travel demands across the state. For instance, shorter distances are observed between neighboring locations like Minna and Bida, while longer distances are evident between more distant destinations such as Minna and Borgu. This variation suggests that trip generation and passenger patterns are influenced by factors such as geographic proximity, economic activities, and the availability of transportation infrastructure.

These findings are consistent with existing research on intercity travel behavior and trip generation patterns. Scholars like Golob (2003) highlight the role of distance decay effects in shaping travel behavior, where shorter distances tend to have higher trip frequencies, and vice versa. Additionally, studies by Ji et al. (2019) underscore the impact of urbanization and economic development on travel patterns, with longer distances often associated with economic hubs and regional centers.

The implications of these findings for transportation planning and policy formulation are significant. Policymakers can use insights into trip distances and travel patterns to optimize public transport services, route planning, and infrastructure investments. For instance, shorter-distance trips may require frequent, localized services, while longer-distance routes may benefit from higher-capacity transportation modes or express services. Furthermore, addressing the diverse travel demands across different origin-destination pairs can improve

accessibility and connectivity within Niger State, thereby contributing to economic development and enhancing the quality of life for residents.

Table 5: Passengers Trip Duration

				DURATION OF TRIP (HOUR & MIN)						
S/NO	ORIGIN	BIDA	LAPAI	SULEJA	MOKWA	KONTAGORA	SHIRORO	MASHEGU	NEW BUSSA	MINNA
1	MINNA	2hr 15min	1hr 42min	2hr 3min	4hr 22min	4hr 1min	1hr 19min	6hr 23min	6hrs 22mi	1hr 1min
2	BIDA	1hr 8min	2hr 36 min	4hr 9min	2hr 15min	5hr 223	3hrs 36min	4hr 45min	4hr 15min	2hr 15min
3	SULEJA	4hr 9min	1hr 21min	41min	6hr 4min	5hr 52min	3hr 8min	8 hr 8min	8hr 4min	2hr 1min
4	KONTAGORA	5hr 23min	5hr 31min	5hr 53min	3hr 59min	1hr 8min	5hr 6min	2hr 13 min	4hr 15min	3hr 54min
5	LAPAI	2hr 34min	48min	1hr 28min	4hr 46min	5hr 34min	2hr 56min	7hr 17min	6hr 46mi	1hr 43min
6	SHIRORO	3hr 32min	2hr 54min	3hr 17min	5hr 40 min	5hr 8min	38min	7hr 30min	7hr 40min	1hr 17min
7	MOKWA	1hr43min	4hr 49min	6hr 28min	52min	4hr 1min	5hr 48min	2hr 50min	2hr 3min	4hr 26min
8	MASHEGU	4hr 48min	7hr 21min	8hr 18 min	2hr 49min	2hr 15min	7hr 28min	1hr 8min	3hr 5min	6hr 15min
9	NEW BUSSA	4hr 16min	6hr 49min	8hr 19min	2hr 1min	4hr 16min	7hr 45min	3hr 5min	1hr 30sec	6hr 24min

Source: Author's Computation (2024)

The discoveries concerning the duration of intercity trips across various origin-destination pairs in Niger State as shown in Table 5 offer valuable insights into the generation of these trips and the trends in public passenger transport. It is evident that trip durations vary considerably depending on the distance between the starting and ending points. For instance, shorter durations are noted for journeys between proximate locations like Minna and Bida, whereas longer durations are evident for trips involving more distant destinations such as Minna and Mashegu or Borgu. This indicates that trip duration is influenced by factors like geographic distance, road conditions, and the availability of transportation infrastructure.

These findings align with existing research on intercity travel behavior and trip generation patterns. Studies by Schmöcker et al. (2006) and Guo et al. (2017) underscore the correlation between trip duration and distance, with longer trips typically associated with greater distances traveled. Moreover, research by Currie and Delbosc (2010) emphasizes the impact of infrastructure quality and travel conditions on trip duration, where longer travel times are often linked to poorer road conditions or congestion.

The implications of these findings for transportation planning and policy formulation are significant. Decision-makers can utilize insights into trip duration to optimize public transport services, plan schedules, and make infrastructure investments more effectively. For example, longer-duration trips may necessitate the incorporation of additional amenities or comfort measures for passengers, whereas shorter-duration trips may benefit from enhanced connectivity and increased service frequency. Additionally, addressing the variability in trip duration across different origin-destination pairs can lead to a more efficient and accessible transport system overall.

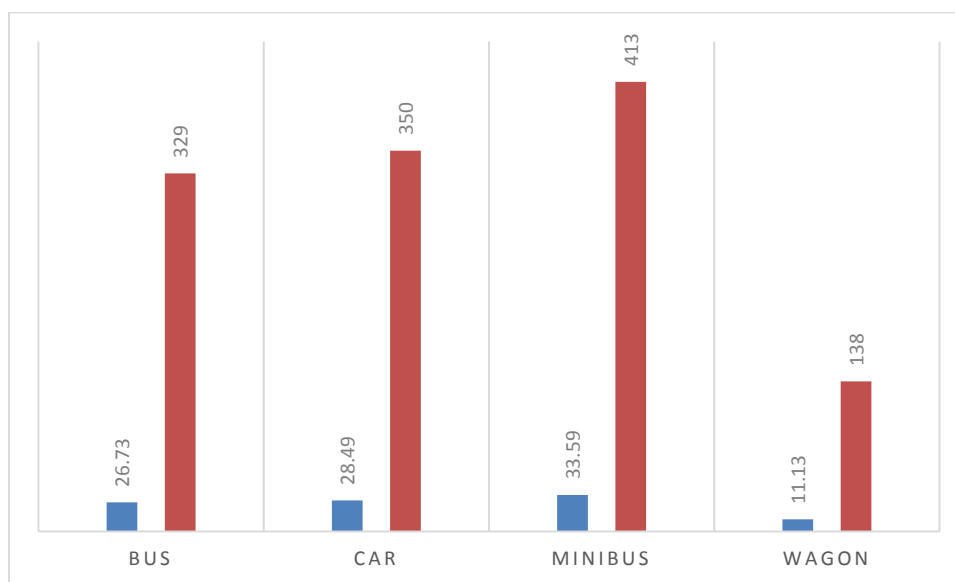


Figure 3: Distribution of Different Modes of Intercity Transport used by Passengers
Source: Author's Computation (2024)

Figure 3 shows the distribution of different modes of intercity transport used by passengers in Niger State, based on percentage and frequency of usage. Minibuses are the most commonly used mode of transport, accounting for 33.59% of the trips, with a frequency of 413. This is followed by cars, which constitute 28.49% of the trips (350 trips). Buses are also widely used, making up 26.73% of the trips with a frequency of 329. Wagons are the least utilized mode, representing 11.13% of the trips, with a frequency of 138.

Policymakers in Niger State should focus on enhancing the intercity public passenger transport system by addressing the specific needs and challenges of each transport mode. This includes investing in minibuses by ensuring their safety, efficiency, and availability through fleet upgrades, improved maintenance standards, and enhanced service frequency.

Additionally, support for car travel can be achieved by improving road infrastructure, providing adequate parking facilities, and introducing carpooling incentives to reduce congestion. Bus services should also be enhanced by improving comfort, reducing travel times, and ensuring punctuality to make them more attractive to users. Furthermore, understanding the reasons behind the lower usage of wagons can help develop strategies to make this mode more appealing, possibly by targeting specific user groups or improving service conditions. By addressing these specific needs, policymakers can enhance the overall efficiency and user satisfaction of intercity public passenger transport in Niger State.

Table 6: Passengers Distributions across Selected Terminals in Niger State

Name of the Motor Park	Commercial(Private Owned)	Public (Government-Owned)	Total	(%)
Etsu Nupe Park Bida	79	31	110	9
Central Park Kontagora	81	42	123	10
Lapai Park	82	35	117	9.5
Abdulsalam Park Minna	221	5	226	18.4
Mobil Park Minna	128	12	140	11.4
NSTA Park Minna	22	20	42	3.4
Mashegu Central Park	25	13	38	3.1
Mokwa Park	119	8	127	10.3
Old Garki Park Suleja	100	43	143	11.6
Shiroro Park	63	15	78	6.3
Dantoro Park New Bussa	75	11	86	7
Total	995	235	1230	100

Source: Author's Computation (2024)

Table 6 details the distribution of intercity trips from various motor parks in Niger State, distinguishing between commercial (private-owned) and public (government-owned) transport services. Abdulsalam Park in Minna is the busiest, generating 226 trips (18.4% of the total), predominantly through private operators (221 trips). This underscores Minna's role as a central hub for intercity travel, especially via commercial transport. Similarly, Mobil Park in Minna is significant, contributing 140 trips (11.4%), further highlighting Minna's importance in the state's transport network. Studies such as those by Banister and Button

(1993) and Hensher (2007) have emphasized the importance of understanding commuter preferences and behaviors in shaping transportation policies and infrastructure development. The implication of these findings underscores the need for investment in public transportation systems, particularly in enhancing the availability and efficiency of minibuses, to accommodate the high demand and alleviate congestion on roads. Additionally, efforts to promote alternative modes of transportation such as carpooling and cycling could help address environmental concerns and improve overall mobility within the region (Litman, 2009).

Other key motor parks include Old Garki Park in Suleja, which generates 143 trips (11.6%), and Mokwa Park with 127 trips (10.3%). Most of these trips are managed by private operators, indicating a strong reliance on commercial transport services statewide. Although less dominant, government-owned services are crucial in parks like Central Park Kontagora and Old Garki Park Suleja. This distribution suggests a significant dependence on private transport services for intercity travel, pointing to the need for policymakers to improve regulations, infrastructure, and support for private operators to enhance service quality. Furthermore, strengthening government-owned transport services is necessary to provide reliable alternatives and ensure balanced growth in the intercity transport sector.

However, the presence of public motor parks underscores the necessity for government intervention to ensure equitable access to transportation services and regulate the transport sector for safety and efficiency. These findings resonate with existing literature on transportation governance and the roles of public and private actors in providing passenger transport services. Scholarly works by Gwilliam and Harpham (2016) underscore the importance of public-private partnerships in delivering transport infrastructure and services, while studies by Ostrom *et al.* (2015) stress the need for effective governance mechanisms to ensure sustainable and inclusive transport systems. In sum, understanding the distribution of motor parks between commercial and public entities yields valuable insights into the dynamics of intercity trip generation and patterns of public passenger transport in Niger State. Such insights enable informed decision-making for transportation planning and policy formulation efforts.

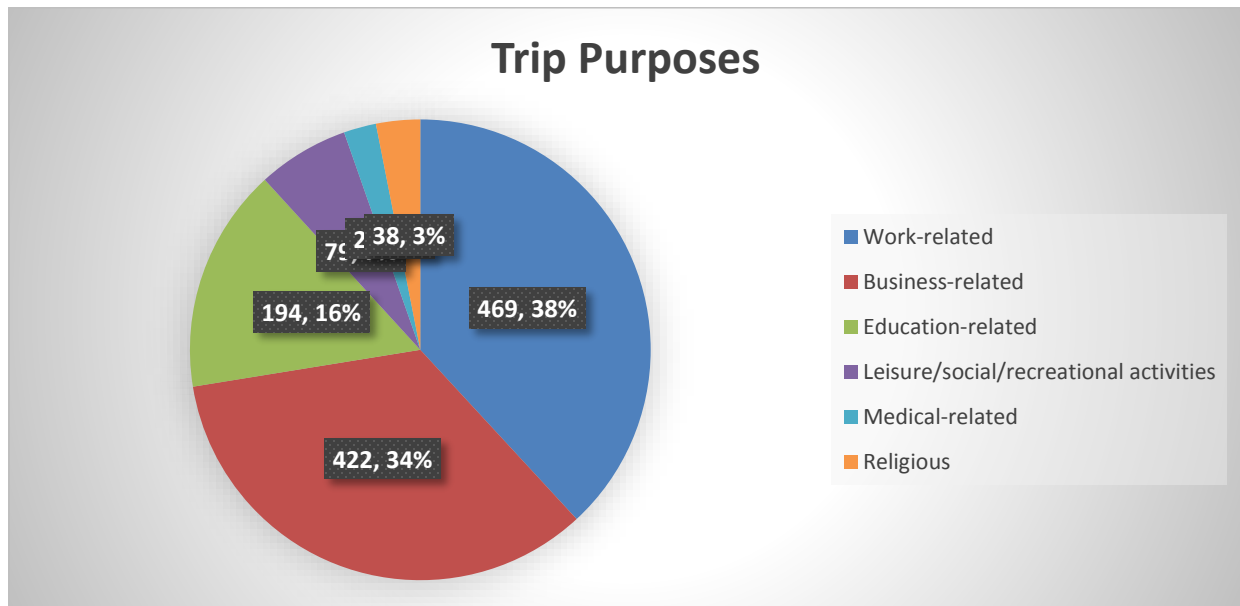


Figure 4: Trip Purposes among Public Passenger Transport Users in Niger State
Source: Author's Computation (2024)

Figure 4 categorizes the purposes of intercity trips of public transport passengers in Niger State, revealing that work-related trips form the largest segment at 38.1%, followed by business-related trips at 34.3%. Education-related travel accounts for 15.8% of trips, leisure or social activities make up 6.4%, and medical-related and religious trips are smaller, at 2.2% and 3% respectively out of 1,230 trips. These findings hold substantial implications for transportation planning and policy formulation within Niger State. Understanding the diverse purposes behind intercity trips can inform resource allocation and guide the development of transportation services tailored to meet the specific needs of different traveler segments. For instance, offering efficient and cost-effective transportation options customized to education-related travel can facilitate access to educational institutions and foster academic mobility. Similarly, addressing the transportation demands associated with business and work-related trips can significantly contribute to economic growth and enhance productivity levels across the region.

To support the predominant work and business travel (72.4%), policies should aim to enhance transport infrastructure, focusing on reliable and frequent services, reduced travel

times, and improved connectivity between commercial and industrial areas. The significant proportion of education-related trips (15.8%) highlights the need for dedicated student services, such as school buses and discounted fares. Leisure trips (6.4%) present an opportunity to develop services catering to social and recreational needs, boosting local tourism. Although medical and religious trips are fewer, ensuring access to healthcare facilities and places of worship is essential, potentially through special transport services for medical appointments and religious events, especially for remote areas. By addressing these specific travel purposes, Niger State can improve the efficiency and convenience of its intercity public transport system to better meet the diverse needs of its population.

In conclusion, this study sheds light on the complexities of intercity traffic composition and public passenger transport characteristics in Niger State, Nigeria. The study reveals crucial demographic trends, travel habits, and infrastructure factors necessary for well-informed decision-making in transportation planning and policy development. Key demographic patterns, travel behaviors, and infrastructure considerations were identified as essential for informed transportation planning and policy formulation.

The findings underscore the need for tailored interventions to address disparities in access, enhance connectivity, and promote sustainable transportation options. By prioritizing investments in public transit infrastructure, improving service reliability and affordability, and fostering public-private partnerships, policymakers can create a more inclusive and efficient transportation system that meets the diverse needs of Niger State's residents. Overall, this study provides valuable insights that can guide future research and policy decisions aimed at optimizing intercity transportation in Niger State.

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UNLEASHING HUMAN POTENTIAL: THE IMPACT OF HUMAN RESOURCE MANAGEMENT ON NATIONAL DEVELOPMENT: THE NIGERIAN PERSPECTIVES

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ABSTRACT:

Innovation has revolutionized the way we live, work, and interact, having a profound impact on human capital development and national progress. This qualitative study explores the dynamic relationship between innovation, human capital development, and national development. The study reveals that innovation-driven human capital development is a critical driver of national progress, fostering economic growth, social prosperity, and political stability. However, education system, fails to provide students with the skills and knowledge needed to succeed in a rapidly changing world. Additionally, outdated curricula, shortage of qualified teachers and poor funding, brain drain, poverty, and inequality among others further exacerbate the challenge. To this study recommend that government should invest in quality education and training programs that focus on developing relevant skills for the 21st century. This includes STEM education, entrepreneurship, and critical thinking. There is need to foster in a culture of innovation and creativity through initiatives vis-a-vis, addressing brain drain by providing incentives and opportunities for talented Nigerians to return and contribute to the country's development. Finally, prioritizing human capital development and innovation in national policies and strategies, and providing leadership and political will to drive these efforts, can help unleash Nigeria's full potential and accelerate national development.

Keywords: innovation, human capital development, national development, economic growth, social prosperity, sustainable development.

Introduction

The impact of innovation on human capital development and national development has been a subject of increasing interest in recent years. As noted by scholars such as Porter and Stern (2001), innovation has the potential to drive economic growth, improve productivity, and enhance competitiveness. Moreover, innovation has been recognized as a key factor in the development of human capital, as it enables individuals and organizations to acquire new skills, knowledge, and capabilities (OECD, 2015).

In the context of national development, innovation has been identified as a critical driver of progress, enabling countries to address complex challenges, improve living standards, and achieve sustainable development goals (UNESCO, 2017). As argued by authors such as Florida (2014), innovation has the potential to transform economies, societies, and political systems, leading to greater prosperity, equality, and well-being.

Nigeria, like many other developing countries, faces significant challenges in harnessing innovation to drive human capital development and national progress. Despite its vast natural resources and large population, Nigeria has struggled to achieve sustainable economic growth, reduce poverty and inequality, and improve living standards (World Bank, 2020). The country's low level of innovation capacity, inadequate investment in human capital, and limited adoption of new technologies and business models have hindered its ability to compete globally and address complex development challenges (OECD, 2018).

In recent years, Nigeria has recognized the importance of innovation in driving economic growth and development, and has introduced various initiatives aimed at promoting innovation and entrepreneurship (Federal Ministry of Science and Technology, 2019). However, the country still faces significant challenges in terms of inadequate infrastructure, limited access to education and training opportunities, and a lack of effective policies and frameworks to support innovation and human capital development (UNESCO, 2019).

This study aims to explore the impact of innovation on human capital development and national development in Nigeria, with a focus on the mechanisms, policies, and strategies that can help harness innovation for sustainable and inclusive growth. By examining the Nigerian context, this research seeks to contribute to the ongoing debate on the role of innovation in driving human capital development and national progress, and to provide

insights for policymakers, business leaders, and other stakeholders seeking to promote innovation and sustainable development in Nigeria.

Problem statement:

Despite the growing recognition of the importance of innovation in driving human capital development and national progress, many countries continue to struggle with low levels of innovation, inadequate investment in human capital, and slow economic growth. The gap between innovation leaders and laggards is widening, with some countries experiencing rapid innovation-driven growth while others are left behind (OECD, 2019).

Nigeria faces a significant challenge in harnessing innovation to drive human capital development and national progress, despite its recognition as a crucial driver of economic growth and development (Federal Ministry of Science and Technology, 2019). The country's low level of innovation capacity, inadequate investment in human capital, and limited adoption of new technologies and business models have resulted in low productivity and competitiveness (OECD, 2018); high poverty and inequality rates (World Bank, 2020); limited access to quality education and training opportunities, particularly for marginalized groups (UNESCO, 2019); brain drain and talent flight (National Bureau of Statistics, 2020); inadequate infrastructure and lack of effective policies and frameworks to support innovation and entrepreneurship (Federal Ministry of Science and Technology, 2019). Specifically, the following problems persist: Low investment in research and development (R&D) and innovation infrastructure (National Bureau of Statistics, 2020) insufficient development of skills and competencies necessary for innovation-driven growth (WEF, 2018); limited adoption of new technologies and business models, particularly among small and medium-sized enterprises (SMEs) (McKinsey, 2019) inadequate policies and frameworks to support innovation and entrepreneurship, particularly for marginalized groups (Federal Ministry of Science and Technology, 2019).

Addressing these challenges requires a deeper understanding of the impact of innovation on human capital development and national development in Nigeria, as well as the development of effective policies and strategies to harness innovation for sustainable and inclusive growth.

Literature Review

Innovation and Human Capital Development:

Innovation and human capital development are intricately linked, and Nigeria has been working to enhance its human capital skills to drive economic growth. Recent initiatives like the Nigeria Innovation and Entrepreneurship Program (2022) and the National Digital Skills Strategy (2021-2030) aim to upskill and reskill the workforce, promoting innovation and entrepreneurship (FMCDE, 2022). The government has also launched programs like the N-Power initiative, which provides training and empowerment for young Nigerians, and the Revitalization of Education Infrastructure initiative, which focuses on upgrading educational facilities (FME, 2022). Furthermore, private sector players like Andela and Google have established programs to develop tech talent and enhance digital skills in Nigeria (Andela, 2022, Google, 2022). Despite these efforts, challenges persist, including a shortage of skilled labor, high unemployment, and inadequate healthcare, underscoring the need for sustained investment in human capital development to drive innovation and economic progress (World Bank, 2022; UNDP, 2022).

Investment in human capital (education, training, and skills development) is positively correlated with innovation and economic growth (Barro, 2001; OECD, 2015). Human capital is a critical factor in the innovation process, as it enables individuals and organizations to generate and apply new ideas (Florida, 2014).

Nigeria's innovation capacity is constrained by inadequate investment in human capital, particularly in science, technology, engineering, and mathematics (STEM) education (Oyebisi, 2017). Developing skills and competencies in innovation and entrepreneurship can enhance human capital development in Nigeria (Adeyemi, 2017).

Innovation and National Development:

Innovation is a key driver of economic growth and national development, as it enables countries to move up the value chain and compete globally (Porter, 1990; World Bank, 2019). Innovation can help address complex development challenges, such as poverty, inequality, and sustainability (UNESCO, 2017).

Innovation is critical for Nigeria's economic growth and national development, as it can help address challenges such as poverty, inequality, and unemployment (Akinseye, 2018).

Nigeria's innovation ecosystem requires supportive policies, infrastructure, and funding to drive innovation and national development (Oyebisi, 2017).

Unleashing Human Potential:

Investing in human capital and innovation can help unleash human potential, leading to increased productivity, creativity, and entrepreneurship (Schultz, 1961; Florida, 2014). Creating an enabling environment for innovation, including access to education, funding, and infrastructure, is critical for unleashing human potential (OECD, 2015). Investment in education and training is essential for unleashing human potential in Nigeria (Adeyemi, 2017). Entrepreneurship and innovation can help unlock human potential in Nigeria, leading to economic growth and development (Akinseye, 2018).

Methodology

The study is qualitative in nature and its uses content analysis involves a systematic and iterative process to analyze textual data, such as documents, articles, or social media posts. The researcher maintains a reflexive and transparent approach, documenting decisions, assumptions, and biases to ensure the trustworthiness and credibility of the findings.

Theoretical Framework

This study adopts multiple theories to examine the relationship between human potentials and national development. The theories include Human Capital Theory, Innovation Theory, Entrepreneurship Theory and Knowledge Economy Theory. The theories are relevant to this study, because their assumptions are key driver of economic growth and development.

Innovation Theory (Schumpeter, 1942): This theory argues that innovation is a key driver of economic growth and development, as it enables countries to move up the value chain and compete globally. Entrepreneurship Theory (Kirzner, 1973): This theory posits that entrepreneurship is a key driver of economic growth and development, as it enables individuals to create new businesses and innovations. Knowledge Economy Theory (Drucker, 1969): This theory argues that knowledge and innovation are key drivers of economic growth and development in the modern economy. Human Capital Theory (Schultz, 1961): This theory posits that investment in human capital (education, training, and skills development) is essential for economic growth and development.

Discussion of the Findings

Human capital development is crucial to national development as it enables individuals to acquire the skills, knowledge, and competencies necessary to contribute to the economic, social, and political growth of a nation. The findings of unleashing human potential reveal that investing in human capital development has a profound impact on innovation, leading to accelerated national development. In Nigeria, for instance, initiatives that focus on upskilling and reskilling the workforce, such as the Nigeria Innovation and Entrepreneurship Program, have led to a surge in innovative startups and small businesses. This, in turn, has driven economic growth, created new job opportunities, and increased the country's global competitiveness. Moreover, Nigeria's efforts to develop its human capital has led to significant advancements in sectors like technology, healthcare, and finance, showcasing the potential for innovation to transform industries and drive national progress. By unleashing human potential, Nigeria has been able to tap into its vast talent pool, foster a culture of innovation, and make strides towards achieving its development goals, demonstrating the critical link between human capital development, innovation, and national development. As Nigeria continues to prioritize human capital development, it is likely to see even more remarkable breakthroughs and progress, serving as a model for other nations to follow.

Despite the potential for human capital development to drive innovation and national progress, Nigeria faces significant challenges in unleashing its human potential. One major hurdle is the country's struggling education system, which often fails to provide students with the skills and knowledge needed to succeed in a rapidly changing world. Additionally, inadequate funding, outdated curricula, and a shortage of qualified teachers further exacerbate the issue. As a result, many Nigerians lack the necessary skills to contribute to innovation and economic growth, hindering the country's ability to compete globally. Furthermore, brain drain, poverty, and inequality also hinder human capital development, as many talented individuals emigrate in search of better opportunities or are unable to access quality education and resources. These challenges have a ripple effect, stifling innovation and national development, and underscoring the need for urgent reform and investment in human capital development to unlock Nigeria's full potential.

Conclusion:

Unleashing human potential is crucial for driving innovation, human capital development, and national development in Nigeria. Investment in education, training, and innovation infrastructure is essential for developing the skills and knowledge necessary for economic growth and development. Nigeria's innovation capacity is constrained by inadequate investment in human capital, particularly in STEM education, and a lack of effective policies and strategies to harness innovation and human capital development. To unleash human potential and harness the power of innovation for national development in Nigeria, several recommendations were made. Firstly, investing in quality education and training programs that focus on developing relevant skills for the 21st century is crucial. This includes STEM education, entrepreneurship, and critical thinking. Secondly, fostering a culture of innovation and creativity through initiatives like incubators, accelerators, and hackathons can help identify and support talented individuals. Thirdly, addressing brain drain by providing incentives and opportunities for talented Nigerians to return and contribute to the country's development is essential. Fourthly, promoting public-private partnerships to fund research and development, and providing infrastructure and resources for innovation hubs can help drive economic growth. Finally, prioritizing human capital development and innovation in national policies and strategies, and providing leadership and political will to drive these efforts, can help unleash Nigeria's full potential and accelerate national development. By implementing these recommendations, Nigeria can unlock the innovative potential of its citizens and drive sustainable economic growth and national progress. By implementing these recommendations, Nigeria can unleash its human potential, drive innovation, and achieve sustainable economic growth and development.

Albeit this study provides rich and in-depth insights; it is not without limitations. One of the primary limitations qualitative studies are often context-dependent and the findings may not be applicable to other contexts. Establishing cause-and-effect relationships can also be challenging in qualitative studies. Moreover, replicating the exact conditions of a qualitative study can be difficult, which can limit the ability to verify the findings. To address these limitations, future qualitative studies can employ several guides. Firstly, triangulation can be used to increase validity by combining multiple data sources and methods. Member checking

can also be used to verify the findings with participants to ensure accuracy. Peer debriefing, or regularly discussing the findings with colleagues, can help reduce researcher bias. Keeping an audit trail, or documenting all steps of the research process, can increase transparency. Utilizing software such as NVivo or Atlas.ti can aid in data analysis. A mixed-methods approach, combining qualitative and quantitative methods, can provide a more comprehensive understanding. Longitudinal studies, conducted over extended periods, can provide deeper insights. Collaboration with interdisciplinary teams can bring diverse perspectives, and reflexivity, or regularly reflecting on one's own biases and assumptions, can increase researcher awareness. Finally, ethical considerations, such as prioritizing participants' privacy and informed consent, are essential. By acknowledging these limitations and following these guides, future qualitative studies can increase their rigor, validity, and contribution to knowledge.

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INTEGRATION OF TECHNOLOGICAL INNOVATION (ICT) INTO ISLAMIC EDUCATION FOR SUSTAINABLE DEVELOPMENT IN NIGERIA.

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ABSTRACT

Islam is a religion with guiding principles. Thus, from its advent, Islam has been commanding Muslims to seek for purposeful knowledge that will enhance their attainment of spiritual, social and economic goals. The first divine revelation to the messenger of Allah, Muhammad (SAW) enjoins mankind to seek for knowledge, hence, the Prophet (SAW) detailed that, seeking knowledge is obligatory upon every Muslim. He also mentioned that one can go as far as China to seek for inclusive and beneficial knowledge. As such, Islam welcomes the use of technological innovation to teach, learn and explore the treasures of Allah on earth and in heaven for sustainable development. Furthermore, Islam through its principles (Shari'ah) handles all the ill effects surrounding such innovations. This paper therefore aims at discussing the meaning of technology, its position in Islam, the benefit of ICT to Muslims. The study adopts survey methods; hence, library was used to review related literature and personal observation. The study discovered some negative impacts of ICT to social and spiritual life of people in the society. Also, it found out that ICT aids quick and easy way of disseminating information in teaching and learning. Finally, the paper recommends among others that technological innovations should be guided by the context of the divine revelation. Also, the government should control or curb the misuse of innovative technology by the masses.

Key words: Integration, Technological Innovation, Islamic Education, Sustainable Development

Introduction:

In the early days of Islam down to the period before the advent of social media, the spread of Islamic message was limited to primary and orthodox methodology. Teaching and learning were based on memorization, written and printed materials like the text books and manuscripts. This was because the communication tools such as television, mobile phones, computer etc. were lacking (not available). As earlier mentioned, the most widely used means of communication at that time was what scholars memorized; and because many were illiterates written text of the Qur'an, hadith, fiqh, sirah etc. were available in few hard copies. Gyayenda (2021) observed that there was minimal reading and writing because the materials for writing were less and not so many people were literate.

However, with the advent of Information Communication Technology (ICT), learning, preaching and teaching became improved, easier and faster which makes one to have access to internet services without much stress. As such, Islamic resources /materials can be transformed into digital forms and be easily distributed across the globe through the information communication technology (ICT). ([https://edubirde .com](https://edubirde.com) ----muslim and Shuhari, Ismail, Ali, AL-Shafi'i and Akib, 2020). Moreso, with this new technology, the Muslim Ummah can communicate and interact with each other, teach, learn, exchange ideas and clarify issues by using various social media platform, programs and Applications (e.g.WhatsApp, Facebook, you tube,Instagram etc.).Yasmansyah,,Lainah, Zulfam and Sesmiarni (2021) submitted that no one can escape the influence of technological development because it is not only felt by individuals, but also by the community, state, nation and the world at large.

The meaning of Technology

Ramey (2013), describes technology as a process and product used to simplify our daily life errands. He maintains that, almost everything we do in our daily lives involves the use of technology; that we use technology for communication, transportation, learning, manufacturing, security, data, scaling, business and many more things.Shuhari et.al. (2020) explain that technology means the application of scientific knowledge for practical purpose. They stated further that technology can also mean applied science and mentioned that it is the manifestation of knowledge that is developed by man in order to bring simplicity into the life of man.

From the above definitions of technology, it is clear that technology is important and necessary in our daily activities because it simplifies the ways through which information and communication is disseminated. As such, the importance of the use of ICT in learning and teaching Islamic education cannot be over emphasized.

Position of Science and Technology in Islam

Kamali (2017) explained that Islam is in support of scientific research that brings benefit to humankind and other creatures of Allah. However, the knowledge of science and technology that is predominantly harmful is discouraged by Islam. Therefore, the Islamic view of

technology and science is based on the purpose such technology is meant for. Jarir reported that the Prophet (SWA) said that:

Whoever institutes a good practice in Islam will have its reward and that of whoever acts upon it without diminishing their rewards in slightest way (Muslim 1017).

Kamali (2017) continued to explain that if science and technology are used to facilitate better methods of truth discovery without any violation of Islamic principles then, there is no doubt that it is acceptable in Islam. Leli, Sunarya, Lutfan, Santoso and Toyiba (2021) also assert that Islam encourages Muslims to study science and spread technology. They stated further that in Islam, technology embodies the components of the verses that enjoin that Muslims should explore and seek the truth. As a result of these injunctions, there were great Muslim intellectuals that were competent in the field of science and technology. Yasmansyah, Lainah and Sesmiarni (2021) noted that Muslim scientists were pioneers for advancement of Islamic civilization in all fields of science long before the philosophy of science was formulated. This progress in sciences was attained as at the time, Europe was in dark ages. Zedan, Yusoff and Mohamed (2015) opined that “using technology for the purpose of advancing knowledge and scientific thinking has always been the tradition of Islam. The Qur’an consistently praises those who contemplate and observed the nature so as to reach the awareness of the might of Allah and the greatness of His creations.

Some of the verses that encourage the pursuit of science and technology include:

Verily, in the creation of the heavens and the earth, and in the alteration of night and day, there are indeed signs for men of understanding those who remember Allah (always and in prayers) standing, sitting and lying down on their sides and think deeply about the creation of the heavens and the earth, (saying) ‘Our Lord, You have not created (all) this without purpose, glory to You, (exalted are you above all that they associated with you as partners). Give us salvation from the torment of fire. (Q 3: 190-191)

And He also says:

O assembly of jinn and men, If you have power to pass beyond the zones of the heavens and the earth, then pass beyond (them) but you will never be able to pass them except with the authority (from Allah) (Q 55: 33).

Yasmansyah, Laninah and Sesimiarni (2021) confirmed that there are several verses in the Qur'an that enjoin Muslims to think, observe, look, contemplate and study the creations of Allah. Thus, man is enjoined to use his mind and senses correctly about the reality around him in order to live in peace and to be grateful to Allah that creates. This is because, education in Islam is a process that transfers moral values and knowledge that will develop the whole potential of man and man becomes balanced and acts in accordance to the principles of shari'ah. Ismail, Abdullatiff, Yacob, L. Ismail and Kandil (2016) expressed that the ability to think makes man to develop a concept, idea, opinion and perception on some issues, thus, it leads man to the acquisition of knowledge and science.

The benefits of ICT to the Muslims

From our discussion, Islam encourages anything that improves the quality of life of man, thus, it has encouraged the use of technology because it enhances the life of man. However, technology has brought both benefit and harm to man, although the benefit is more than the harm. Ismail et al (2016) observed that integration of ICT to the curriculum of Islamic education is not only essential but it serves as an easy means to understand current global issues and challenges; and as well offers new ways of getting over them. Gyagenda (2021) is also of the opinion that, the traditional methods of teaching Islamic education need to be reinforced with ICT. Therefore, the syllabi and curricula should be designed in such a way that it would integrate the use of ICT in teaching and learning process. This is because the new generation of learners have embraced the use of technology through their computers, android phones, internet and social media. In addition, ICT makes the teachers to connect and relate well with the students / learners.

Jusoh and Jusof (2009) mentioned that educational technology and multimedia would only be a valuable means of attaining set goals only if it is integrated into the curriculum appropriately. They continued that it aids an exciting learning environment and motivate the

interest of the students. But this depends on the type of method the teacher uses to disseminate knowledge to the students.

As earlier mentioned, the use ICT to spread Islamic education is very essential because it makes teaching and learning faster and easier. Muslims across the globe can take part in the online classes or participate in virtual lectures that are conducted by reputable and notable scholars. Nowadays, ICT makes fiqh, sirah and other aspects of Islamic education more effective. (Edubirdie 2024).

ICT is used to increase our knowledge and awareness which the Qur'an has emphasized in Q96: 1-5 where Allah says:

Read in the Name of your Lord Who has created (all that exists)

He has created man from a clot (a piece of thick coagulated blood)

Read! And your Lord is the Most Generous.

Who has taught (the writing) by the pen.

He has taught man that which he knew not.

The Prophet also enjoins that seeking for knowledge is compulsory on every Muslim (Ibn Majah). The Prophet also advised that one can go as far as China to seek for purposeful knowledge. As such, Muslims embrace new technology that does not contradict the shari'ah because of its benefits to humankind.

With the use of ICT, conferences and symposia are conducted virtually and they make it easy for all those that are interested to participate (Rosenberg 2004). Hossein, Ramchahi, Jamilah and Yusuf (2014) expressed that the development of Islamic software and applications (Islamic finder, shamilah software, Qur'an and hadith software) really facilitate the accessibility of Qur'an, hadith, fiqh and some other Islamic subjects and teaching in digital formats for laptops, mobile phones, iPod, Islamic websites etc. Technology also helps the Muslims in the non-Muslim areas to have access to Islamic learnings, teachings and information. To a greater extent, some misunderstanding and misconception on Islam and

Islamic education were clarified online by notable scholars throughout the world through social media platforms, video clips, virtual lectures etc. (Rosenberg 2004). From this discussions, ICT have created an avenue through which Islamic resources can be transformed digitally and easily distributed across the world within a short period of time.

Sorooshian and Teck (2020), assert that the technological growth and internet services such as YouTube, Facebook, WhatsApp, Instagram, Pdf and Microsoft are sources of software information which have enabled users, especially the students, to have easy means of accessing online information, learning and teaching. Thus, the use of technology is so necessary and important in our daily activities. Hussein et al (2014) is of the view that ICT resources have removed the boundaries of language, borders and instructional barriers in such a way one can access Islamic education in their respective languages as well as interact with scholars and other students worldwide.

The use of ICT to spread Islamic education is very important because it helps in molding / guiding the behaviors of man through the online lectures and explanation of the Sunnah of Prophet Muhammad (S). It also aids self-study and learning. Thus, it becomes a better, easy and faster way to transmit knowledge globally through preaching and enlightenment classes online.

ICT helps in solving educational, social and spiritual problems. It gives much motivation to students because they have easy access to information on their smartphones, android phones IOS applications etc. Apart from all these, it replaces huge number of books that are kept in book shelves because it occupies small space. For example, *Al-Maktabah Ash-Shamilah* is an application that has full information on materials in every aspect of Islamic education and it occupies small space on the computer when compared to the hardcopies of such materials on the book shelves.

Moreover, modern ICT such as internet, iPad, mp3 players, some webs and software applications can be used to teach the Qur'an and other aspects of Islamic education easily. Although, this is not so in the rural areas because of non-accessibility to these technologies due to poor internet, illiteracy, poor ICT provision and poverty (Tayan & Alghinah 2014).

As earlier mentioned, there are some few harms or negative impacts of ICT. Some of such harms are; it sometimes serves as threat to the privacy of user. On the other hand Islam highly respect people's privacy. The information and private communication or discussion of people are compromised by third parties without permission or approval from the individuals concerned. Also, morality is compromised with the new technology because one can access all forms of information (good or bad) via the internet. Many bad behaviors are promoted on the internet such as gambling, fraud, hate speech, cultism, illicit relationship etc. (Hossain et al. 2014).

Another harm is that orientalist and the Islamophobs use this same technology in disseminating wrong information and instructions about Islam and unless Islamic educators occupy this space, learners will occasionally encounter false information about Islam in these means (Haque 2016). Another harm associated with ICT is that improper implementation of policies and reluctance to change from the traditional methods of teaching and learning hinder the wide use of ICT in the process of teaching and learning in Nigerian schools (Ogbomo, 2011). Bakaul (2018) commented that for the integration of ICT into the teaching and learning to be successful, the attitudes of teachers and learners should change and accept it as easy means of teaching and acquiring knowledge.

The improper implementation of policy could be seen in lack of enough provision and installation of ICT facilities in schools for teachers of Islamic Studies and other teachers as well. Moreover, there is lack of funds for the teachers to purchase the necessary hard and soft wares that are needed in the teaching and learning process. In addition, at times there will be skilled personnel but the facilities for ICT will not be available. Hence, availability of ICT facilities will encourage the use of ICT in teaching and learning Islamic Studies (Muntazi, 2000).

Conclusion

Islam emphasizes the correct use of our senses for the benefit of humanity. The Qur'an enjoins that we should think and reflect on the creation of Allah. The early Muslims scholars excelled in the field of science advancement at a time when Europe was in dark ages.

However, ICT is very crucial in the life of everyone because it has simplify the ways to acquire and disseminate knowledge worldwide through the use of android phones, Instagram, you tube, software applications etc. Never the less, most people in the rural areas are yet to gain much from ICT because of either failure of network, illiteracy, poverty, lack of computer or carefree attitudes towards adopting its use.

Recommendation

This study recommends that the government should make policies on the integration of ICT in the teaching and learning process and as well implement these policies in our institutions of learning. In order to enhance quick and easy way to teach and learn Islamic Studies, ICT facilities need to be provided and installed.

Also, the government should curb the misuse of innovative technology by the masses through restricting the use of those apps that encourage immorality and deviant from the teachings of our religions.

In addition, educators should guide the learners on effective use of ICT so that they do not waste their time on the ICT. Instead, they will broaden their knowledge and have access to many more sources of Islamic education.

The people in the rural areas should be provided with good network, enlightenment and training on basic ICT skills. This could be done by organizing workshop, seminar etc so that they would make good use of ICT.

More so, the educators and learners should be provided with adequate skills on the use of ICT through regular training and retraining in order to have effective teaching and learning situation.

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CIRCULAR ECONOMY: A CONCEPTUAL REVIEW FROM THE PERSPECTIVE OF SMALL AND MEDIUM ENTERPRISES (SMEs) MANUFACTURING FIRMS

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ABSTRACT

Our current consumption and resource utilization patterns have rendered our environment unsustainable due to the traditional linear economy approach (take-make-disposal). This overbearing has evolved into a paramount challenge for businesses, prompting a standard shift towards circular economy (take-make-use) practices, particularly for Small and Medium-sized Enterprises (SMEs) in the manufacturing sector, the adoption of circular economy principles has emerged as an innovative business model. This study delves into the review of three key circular economy practices—namely, waste treatment, reduction, and recycling in the Small and Medium Enterprises (SMEs) manufacturing firms. Various opportunities arising from the circular economy are highlighted in the study, covering waste collection, inorganic waste processing, and the recycling of paper, plastic, metal, rubber, textiles, and organic waste (composting). Furthermore, the study examines the benefits of embracing the circular economy across businesses, economic, and environmental. These advantages include, increased employment rates, substantial resource savings, economic growth, reduced greenhouse gas emissions, and the preservation of critical soil, air, and water bodies, among others. Despite its merits, the study identifies Consumer behavior patterns and economic barriers as weak points. In order to address these challenges, the study proposes increasing awareness to facilitate a continuous transition to a circular economy.

Keywords: Circular Economy, Waste Treatment, Waste Reduction, Recycling

Introduction

Our global society is currently facing a profound sustainability crisis, as evidenced by a multitude of well-known challenges such as waste accumulation, pollution, climate change, resource depletion, and the alarming loss of biodiversity. These issues are widely recognized, yet they persist and intensify, posing significant threats to both our environment and our way of life. In striving to sustain our economies and accommodate a burgeoning global population, we have long relied on the linear economic model (take-make-dispose). This linear approach hinges on the consumption of cheap and readily available resources to fuel growth and maintain stability. However, this method is increasingly untenable. Over the past decade,

Small and Medium Enterprises businesses have encountered a notable spike in commodity prices, effectively nullifying the average decline observed over the preceding century. This trend underscores the growing strain on finite resources and exposes the vulnerability of our current economic system. Compounding this challenge is the projected addition of three billion more middle-class consumers by 2030, further exacerbating the demand for resources. The unprecedented surge in resource consumption amidst finite supplies raises profound questions about the sustainability of our predominantly linear economic model. It underscores the urgent need for a fundamental shift towards circular and regenerative economic practices. In transitioning to a circular economy, where resources are conserved, reused, and recycled, we can mitigate the pressures on our environment and create a more resilient and sustainable future for generations to come. This imperative calls for concerted efforts from businesses, governments, and society as a whole to rethink our approach to production, consumption, and resource management. Only through collective action and innovative solutions can we address the looming sustainability crisis and chart a path towards an equitable future.

Conceptual Review

According to Mazzucchelli et al (2022) the most frequently quoted definition of Circular Economy in the innovation discourse and used is an economic system designed to minimize waste and make the most of resources, in contrast to the traditional linear economy (make - take- dispose), a circular economy promotes the continual use, recycling, and refurbishment of products and materials. CE is also defined as method to reduce environmental impacts by extending product lifecycles, reducing resource consumption, and promoting sustainability through practices like recycling, remanufacturing, and sharing economies (Kim and Jim, 2022). Circular Economy is a closed-loop system where resources are reused and regenerated, rather than ending up as waste (Mesa et al., 2022). Troise, et al, 2020, define circular economy in their paper as a sustainable and regenerative system in which economic growth is decoupled from resource consumption, leading to reduced environmental impact and a more resilient and prosperous economy. Circular economy is based on the 3Rs, namely recycle, reduce, and reuse, that represents a new business alternative to the prevalent linear

economy approach based on make -take- dispose and it allows the reduction of resource usage and waste production, it addresses issues such as waste reduction, conservation of natural resources, and the mitigation of environmental pollution, contributing to a more sustainable and environmentally friendly future. (Mazzucchelis et al, 2022).

Linear Economy: The linear economy, as defined by Elisha,(2020), is an economy model in which raw materials are extracted, transformed into products, and ultimately discarded as waste after use. The emphasis lies on producing and selling as many products as possible, without significant consideration for resource conservation. This linear approach is deemed inefficient as it leads to the generation of considerable waste. However, in a circular economy, materials are reused, such as recycling waste glass to produce new glass or waste paper to create new paper products. Transitioning to a circular economy involves adopting alternative business models, with a greater emphasis on services alongside products. For instance, the Product-As-A-Service System integrates both products and services, facilitating the transition to circular economic practices.

Circular Economy Dimension

Inorder to gain a proper understanding of the concept and how it has been conceptualized in literature over the years, few papers were review,Usama, et al, (2021),proposed three element of circular economy as Design for Longevity, Reuse and Remanufacturing and Recycling and Recovery. Likewise, Mohajan (2020)developed four basic dimensions of circular economy as Reuse and Remanufacturing: Recycling and Recovery, Resource Efficiency and Sharing and Collaborative. According to Mazzucchelis et al 2020 circular economy involve three basic practices namely, waste treatment, reduction and recycling. While Babbit et al, (2021) gives five dimensioms which are the combination of the three former scholars mentioned above.Circular economy incorporates various dimensions and principles, all of which are interrelated. Some of the key dimensions or aspects of a circular economy include:

Design and Innovation: This dimension focuses on designing products, systems, and processes with the aim of reducing waste, extending product lifecycles, and enabling easier

repair and recycling. Design for disassembly, modularity, and durability are key aspects of this dimension (Mesa, et al, (2022),

Material Flow and Resource Management: Managing the flow of materials and resources in a circular economy involves efficient collection, sorting, and recycling of materials. It also includes the responsible sourcing of materials, reducing resource consumption, and minimizing waste (Mohajan, 2020).

Product Life Extension: Extending the useful life of products through practices such as maintenance, repair, refurbishment, and remanufacturing, this dimension emphasizes the preservation of product value over time (Wang and Zhou., 2019).

Sharing and Collaborative Consumption: Promoting the sharing of products and services to maximize resource utilization and reduce the need for individual ownership. Examples include car-sharing services, tool libraries, and co-working spaces (Yang et al., 2019).

Business Models: Circular business models embrace rethinking how businesses operate. Examples include product-as-a-service models (e.g., leasing or subscription services), resale and buyback programs, and value-added services tied to products.

Consumer Behavior and Awareness: Encouraging consumers to make sustainable choices and become more aware of the environmental impact of their consumption. This dimension involves education, marketing, and incentives for responsible consumption.

Policy and Regulation: Government policies and regulations play a crucial role in promoting and incentivizing circular economy practices. This includes waste management regulations, extended producer responsibility (EPR) programs, and tax incentives for circular initiatives.

Technological Advancements: Advancements in technology, such as IoT (Internet of Things), blockchain, and data analytics, can enhance the tracking, traceability, and efficiency of materials and product cycles in a circular economy.

Collaboration and Stakeholder Engagement: Effective circular economy implementation often requires collaboration among various stakeholders, including businesses, governments, NGOs, and consumers. Partnerships and cooperation are key aspects.

Environmental and Social Impact:

A circular economy aims to reduce environmental impact, including resource depletion and pollution, while also considering social aspects such as job creation and community well-being. These dimensions are interconnected, and the successful implementation of a circular economy typically involves a general approach that considers all of them. It's important to note that the specific focus and priorities may vary depending on the industry, region, and goals of a particular circular economy initiative. As it relates to this study, circular economy is conceptualized by adopting Mazzuccheli et al, (2022) conceptualization of circular economy as Material Flow and Resource Management that consist waste treatment, reduction and recycling, as a way of reducing environmental impact such as resource depletion and pollution of SMEs manufacturing firms

Waste treatment

Waste treatment is an aspect of waste management that involves the processing of waste to make it less harmful to the environment. Mazzucchelli et al; (2022), waste processing can include methods like composting, incineration, and landfilling and others. The goal of waste treatment is to reduce the amount of waste that ends up in landfills and to create useful products or materials from the waste (Elisha, 2020).

Recycling

This is one of the most important elements of waste treatment and the circular economy (Hagelüken et al 2016). The basic idea is to take used materials and turn them into new products, which can help reduce the amount of waste going to landfills and conserve natural resources. Elisha,(2020) gives different types of recycling, such as mechanical recycling (which involves breaking down materials into their basic components and using them to make new products) and chemical recycling (which involve chemically breaking down materials to create new substances).

Waste reduction

The basic means of minimizing or eliminating the amount of waste generated (Gruia et al, 2021). It involves a conscious effort to avoid creating unnecessary waste by choosing products and practices that are more sustainable and minimize the use of resources. By

reducing waste, we can reduce the environmental impact of manufacturing and consumption, reduce the burden on landfills and other waste disposal systems, and conserve natural resources (Mazzucchelli et al, 2022). It's all about finding ways to do more with less.

BENEFITS OF CIRCULAR ECONOMY

Economic development over the last few decades has resulted in increased resource reduction and environmental damage. As a result, governments, institutions, non-governmental organizations, and practitioners have included innovative mechanisms, procedures, and practical solutions in their agendas to assist SMEs Manufacture firms in pursuing their economic goals in an environmentally sustainable manner (Elisha,2020).

Wealth creation

The concept of Circular Economy was offered as a practical option with an emphasis on meeting the dual environmental and economic performance goals, and in fact, the gradual transition to a sustainable economic system is seen as a fundamental component of the European industrial strategy (European Union, 2020, Mazzucchelis, 2022). Firms are becoming environmentally conscious in an environment characterized by environmental preservation and resource conservation (Mazzucchelis, 2022). And in order to reduce the environmental load and relieve resource constraints, they are attempting to fully leverage the potential of recycling for establishing a sustainable transition to Environmental practices, particularly Recycling practices, have been identified as a viable means of generating wealth and are being implemented by businesses due to their effects for performance improvement on environment such as job creation and health environment.

Economic Benefits

Circularity has several advantages for the economy. Several studies have attempted to establish that any enterprises that made commitment and involvement in corporate responsibility such as reducing environmental hazard will improve influence on customer perceptions that could add value to their products and improve their reputation by taking a more responsible approach to sustainability. Environmentally conscious companies could

increase the worth of their products and achieve a better sales and reputation (Gap report 2019). This is because the cost of raw materials will decrease substantially, while promoting employment and innovation

Increase in Employment Rate

In Circular economy labour is more valued than raw materials. As a result, employment is growing. Jobs will expand for labour-intensive recycling and high-quality repairs; jobs in the logistics sector; new enterprises through innovation, service economy and new business models (Elisha, 2020).

Economic Benefits of the Circular Economy

Circularity has several advantages for the economy. Nationally, the economy would benefit trillions of naira a year from more effective resource management. This is because the cost of raw materials will decrease substantially, while promoting employment and innovation.

Environmental Benefits

The main goal of the circular economy is to have a positive impact on the ecological systems, which will not diminish or load them. This is echoed in the ecological benefits of the circular economy. For example, a circular economy emits less greenhouse gases, the soil, air and water remain vital and nature reserves are preserved.

The weak point of Circular Economy

Absence of true pricing (externalities): By not incorporating social and environmental costs in prices economic decisions are based on incorrect market signals;

Limitations on circular business models: Circular business models are more difficult to develop, because financing is more difficult to obtain;

Future investments: Circular business models sometimes require upfront investments, while returns are uncertain or spread out over a longer period. Costs and benefits are often unequally spread over the supply chain due to market power;

Insufficient market demand: The demand for circular product is still limited, hindering the business.

Insufficient personnel: shortages may arise in certain professions needed for a circular economy, for instance professionals with technical or ICT knowledge;

Business processes Complexity: In circular business relations are closer and more intense, both inside a company as with external parties.

CONCLUSION

In conclusion, circular Economy concept is all about changing human and society reasoning from simple disposing waste after resources use to reuse (recycling). The ideas are decades old, but a mixture of environmental and resource price pressures, technological advancements and changes in consumer demand is making it impossible. Sustainable development requires disruptive changes in the way our societies and businesses are organized. The circular economy (CE) model offers a new chance of innovation and integration between our daily lives, waste management, businesses and natural ecosystems.

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SUSTAINABILITY OF RESIDENTIAL PROJECTS IN NIGERIA: A PROJECT MANAGER'S PERSPECTIVE

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ABSTRACT

Sustainability of residential estate projects is a major concern of construction stakeholders which should be a continuous process by successive administration in Nigeria irrespective of the party affiliation. The study explores the Project Manager's perspective in the delivery of the residential development in the Federal Capital Territory, Abuja. Three objectives were examined which include (i) the Project Managers' perception on their own performance on the residential estate development (ii) the factors driving project managers' performance and (iii) strategies on enhancing the performance of Project Managers. Data were collected from 26 project managers on residential estates projects using close – ended - designed questionnaires and were analysed 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. The results of the data analysis were presented using tables and charts. 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 PMs that had the strongest influence on project quality performance, the 'commitment of project stakeholders to sustainable construction' and 'Lack of teamwork' were identified as the key driver and barrier respectively of project managers' performance. As a strategy to enhance performance, the study recommended that real estate development firms should identify how they can leverage the Attitude, Finance, Government Policy, Knowledge, Management, Stakeholder and Technology factors to improve project performance in the short, medium and long term.

Keywords: Projects, Sustainability, Performance, Teamwork

Introduction

Sustainability, is the achievement of a continuous process involving the survival of the human race within environmental constraints (Robinson, 2004 and Sharachchandra, 1991), Sustainability development is now a major part of the mission statement of many global organizations, national institutions, corporate companies, states and localities (Kates *et al.*, 2005). In many parts of the world construction business has come to realize that innovation

that allows use of building materials that are non-harmful and recyclable, should be both profitable and environmentally preferable (Owens and Cowell, 2002).

A high percentage of non-renewable resources consumed across the world are used in the building industry, making it one of the least sustainable industries in the world (Edwards, 2010). The built environment accounts for nearly 40% of natural resources consumed, and 40% of waste and greenhouse gases generated (CIOB, 2004). Buildings use as much as 45% of generated energy to produce power for air-conditioning and heating (Wood, 2005; Reed *et al.*, 2011). Buildings also account for one-sixth of the world's fresh water usage, one-quarter of wood harvested and two fifths of all material and energy flows (Emmanuel, 2004).

It is ironic that the negative impact of the construction industry on the environment provides it with a vital opportunity to contribute towards achieving SD (Gibberd, 2002). The construction industry addresses basic human needs in terms of provision for housing and social infrastructure (Sinha *et al.*, 2013). Du Plessis (2007) noted that the industry has a great challenge, not only to meet the need for adequate housing and rapid urbanization but also to meet this need in a socially and ecologically responsible way. As a response to this challenge, professionals in the built environment have initiated sustainable construction (SC) which is '*the creation and responsible management of a healthy built environment based on resource efficient and ecological principles*' as cited in (Kibert, 1994). SC is seen as a way to create buildings in which the principles of SD are applied to the construction process and consequently produce buildings that are sustainable.

Sustainable buildings minimizes the use of resources such as energy and water, minimizes unwanted outputs such as greenhouse gas, and maximize the health and wellbeing of users (Eley, 2011). From the viewpoint of sustainability, sustainable building refers to the application of sustainability principles to design, construction and management of buildings so as to mitigate the environmental impact of buildings (Balaban and Puppim de Oliveira, 2016)

This paper therefore, focuses on the project manager's performance in mass housing projects at the design and construction stages in order to achieve sustainable construction of

residential housing estates. In order to achieve the aim set for this study, the following questions are formulated

- 1) What is the current PM role/contribution in the sustainable construction of residential housing estates in Nigeria?
- 2) What are the factors that aid or retard the contributions of project managers in the sustainable construction of residential housing estates?
- 3) How can the contributions of project managers in the sustainable construction of residential housing estates be enhanced?

Aim: The study aimed at assessing the performance of project managers on sustainable construction of residential estates developments in FCT, Nigeria, with a view to enhancing sustainability in mass housing delivery.

The objectives of the study are as follow:

1. To examine project managers' perception of their competence in sustainable construction of residential estates developments.
2. To examine the performance of project managers on the sustainable construction of residential estates developments. .
3. To develop strategies for enhancing project managers' performance on the sustainable construction of residential estates developments in Abuja, Nigeria.

Literature Review

Sustainable development and environmental protection have become a major focus for the governments the world over. This is predicated 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, which is an important means of reducing environmental pollution and improving quality of life (Tan, Shen and Yao, 2011).

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, Xia and Skitmore, 2016). Generally, green building/sustainable construction refers to both a structure and the application of processes that are environmentally responsible and resource-efficient. The terms also imply that buildings and the process of constructing them retain these attributes right from planning to design, construction, operation, maintenance, renovation, and demolition; in fact, throughout the building life-cycle (Yudelson, 2009).

Tabassi et al (2016) studied project manager leadership in sustainable building projects. The study resulted in six groups of success indicators: energy efficiency, indoor environmental quality, sustainable site planning and management, materials and resources, water efficiency, and innovation.

Project Managers' Competence

The use of the project management system for delivery of construction projects requires the use of a special business entity, which is known as a project manager. A project manager, according to Zwikael (2011), is the person contractually responsible for meeting the project's output targets, within the constraints (both identified and unidentified), that the project is faced with. With specific reference to the construction industry, project managers thus initiate, plan, execute, monitor and close projects. It is important that project managers are able to handle unexpected situations efficiently (Isa, 2007); this is only possible if project managers possess the required competency in term of skills, knowledge and behavior (Crawford, 2000).

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). Researchers have identified project manager leadership competencies as critical factors of failure or success that can be used to assess project performance (Anantatmula, 2010). It should be noted however, that competencies can be measured with reference to established standards and can

be improved through training. With reference to project management in the construction industry, competence is the ability to perform project activities to recognized standards of performance. Evaluation of competency can be obtained through frameworks such as 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). Lack of project manager leadership competence has been directly linked with failure of projects (Nixon et al., 2012).

Performance of Project Managers

Performance of projects in the construction industry has been measured in a variety of ways, and with respect to several theories. Berssaneti and Carvalho (2015) stated that the stakeholder salience theory suggests that the interests of various stakeholders have a strong influence on project performance. Traditionally however, compliance with cost, schedule and quality targets has been used to measure project performance (Meng, 2012). Although project management processes have a significant impact on project time and cost (Almahmoud, Dolo and Panuwatwanich, 2012), these metrics alone are not 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; Berssaneti & Carvalho, 2015; Yang, Huang, and Hsu, 2014). Evidence from some studies has proved the influence of a project manager's leadership competence on project performance.

"Health and safety management", as a required competence of the project manager, was removed, as all experts held the view that the project manager had done a good job for the health and safety management of workers in the traditional construction process, and the construction technology of green buildings are complex but not highly dangerous. It was pointed out that for project managers, a very important ability is to understand the relevant policies and regulations accurately and industry development trends.

Factors Driving Project Managers' Performance

Asgari, Kheyroddin and Naderpour (2018) averred that each construction project is made up of a unique set of different events, expected or unexpected, which occur during the project life cycle. These events are influenced by certain factors, either in a positive or negative manner. Some of these factors exert more influence than others; these 'special' factors are defined as critical success factors (CSFs). CSFs are "a set of environmental factors which affect the project's outputs. These factors may speed up or slow down the implementation procedure of a project, so that the project eventually succeeds or fails". These factors are not however employed as the basis of project evaluation (Lim and Mohamed, 1999).

CSFs do not exist rigidly for all types of construction projects; in fact CSFs vary not only according to the type of project, but also according to project location, project stakeholders and funding plan for projects. Seven CSFs for public housing projects (PHPs) in Nigeria identified by Mukhtar, Amirudin, Sofield and Mohamad (2017) included: (1) institutional framework for public housing, (2) availability of competent personnel, (3) effective project management, (4) good maintenance management practice, (5) appropriate design and good location, (6) effective housing finance system and (7) adequate political support.

Factors that may affect PM performance in terms of project cost

Factors	Source
Planning and scheduling by contractors; Change in the scope of the project	Azhar et al. (2008); Ameh et al. (2010); Enshassi et al. (2009); UNRWA (2006); Memon et al. (2010)
Frequent design changes; Amount of detailed design at the start of construction; Design effectiveness	Enshassi et al. (2009); Ameh et al. (2010); Chua et al. (1999); Meeampol and Ogunlana (2006)
Slow decision-making; Lack of project leadership skills	Enshassi et al. (2009); Sambasivan and Soon (2007); Iyer and Jha (2005); UNRWA (2006); Memon et al. (2010)
Contractor's poor site management and supervision; Number of control meetings during the construction phase; Number of budget updates	Hoai and Lee (2008); Chua et al. (1999); Azhar et al. (2008)

Factors	Source
Project manager's technical experience; Competence of project team; Labor productivity; Team turnover; Shortage of site workers; Lapses in the management of human resources	Chua et al. (1999); Abdullah et al. (2009); Memon et al. (2010); Okpala and Aniekwu (1988); Meeampol and Ogunlana (2006)
Conflict or coordination among project participants; Communication among partners	Iyer and Jha (2005); Meeampol and Ogunlana (2006)
Number of organizational levels between the project manager and craft workers; Poor contract management	Chua and Loh (1999); Mansfield et al. (1994)
Mistakes during construction; Amount of rework	Palaneeswaran et al. (2008); Hoai and Lee (2008); Sambasivan and Soon (2007); Josephson et al. (2002)
Contractor experience; Contractor's financial management ability	Enshassi et al. (2009); Hoai and Lee (2008); Chan and Park (2005)
Change orders due to enhancements required by client	Nega (2008)
Source: Jin, Shen and Wang (2018)	

Research Methodology

This study adopted a single method approach (quantitative research design), which encompassed the use of questionnaires and historical cost data. The sources of these data included (i) Project managers of residential estates being developed in Abuja; and (ii) Member firms of the Real Estate Developers Association of Nigeria (REDAN).

Purposive sampling technique was used to obtain data from the residential estates building projects in the study area through the project manager handling active ongoing works on site via questionnaire;

Method of Data Analysis and Presentation

The data collected from the responding project managers through the structured questionnaire, and from the responding real estate firms using the archival data collection

form were carefully analyzed in relation to the stated objectives. The analyzed data was presented using tables and charts.

Methods of Data Analysis

Objective number	Objectives	Data Tools	Analysis Instrument
1	examine project managers' perception of their competence in sustainable construction of residential estates developments	Questionnaire	Mean Score; Relative Importance Index;
2	examine the performance of project managers on the sustainable construction of residential estates developments	Archival data/Questionnaire	Mean Score; Relative Importance Index; Percentage analysis
3	determine the factors driving project managers' performance on the sustainable construction of residential estates developments	Questionnaire	Mean Score; Relative Importance Index;

Source: Researcher's fieldwork (2023)

Simple descriptive analysis tools, specifically Mean Score (MS) and Standard Deviation (SD) were employed to reveal which competency components had significant influence on which project performance indices, as perceived by the respondents. The results revealed that the three 'conceptual' competencies (Scoping, Integration and Visioning) have significant influence only on the cost, quality and time performance of residential housing estate projects. The cost of such projects was most strongly influenced by 'Scoping' competency (MS = 2.58); the quality and time performance of projects were most strongly influenced by 'Visioning' competency (MS = 2.69 and 2.62 respectively). These results indicate that 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.

Influence of 'Conceptual' competencies on project performance

Competency group	Competency	Cost	Dispute resolution	Health and	Quality	Time
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components		n		Safety							
		MS	SD	MS	SD	MS	SD	MS	SD	MS	SD
Conceptual	Scoping	2.58	0.64	2.20	0.58	2.30	0.70	2.6	0.63	2.6	0.64
Conceptual	Integration	2.50	0.71	2.19	0.57	2.40	0.65	2.6	0.56	2.6	0.64
Conceptual	Visioning	2.50	0.65	2.27	0.60	2.20	0.72	2.6	0.55	2.6	0.70

Notes: MS = Mean Score; SD = Standard Deviation

Ranking of factors that drive project managers' performance

Driver code	Driver category	Drivers of Project Managers' performance	Mean Score	SD	RII	Rank
C33	Stakeholder	Commitment of project stakeholders including Professional bodies to sustainable construction	4.04	0.86	0.75	1
C6	Financial	Reduced costs, less waste	3.96	1.04	0.79	2
C35	Time	To improve design/construction team responsiveness on sustainable construction	3.88	1.12	0.72	3
C28	Stakeholder	In response to client demands for sustainable construction	3.88	0.90	0.72	4
C36	Time	To improve timely delivery of sustainable projects	3.79	1.10	0.70	5
C24	Quality	To improve quality of services	3.79	1.06	0.70	6
C37	Time	To permit quicker response to new needs of sustainable construction	3.79	1.06	0.70	6
C38	Time	Shorter construction periods of sustainable projects	3.79	1.02	0.70	8
C1	Financial	To achieve cost reduction with enhanced sustainability performance	3.77	1.03	0.75	9
C27	Quality	Improved quality, fewer defects	3.75	1.03	0.69	10
C19	Institutional	High quality education and skills development on Sustainable Construction	3.73	1.08	0.75	11
C15	Operational	Improved productivity on projects	3.72	0.94	0.72	12
C12	Operational	Availability of trained professionals	3.68	1.03	0.71	13
C25	Quality	Greater predictability of project cost, time and quality	3.67	0.96	0.68	14

Driver code	Driver category	Drivers of Project Managers' performance	Mean Score	SD	RII	Rank
C17	Institutional	Government policies on Sustainable Construction (SC)	3.65	0.94	0.73	15
C11	Operational	To conform to senior management or directors' leadership	3.65	0.89	0.73	16
C30	Stakeholder	To improve stakeholders' satisfaction with sustainable construction	3.63	1.10	0.67	17
C23	Quality	To improve performance standard of sustainable buildings	3.61	1.12	0.64	18
C26	Quality	Improved safety and health	3.58	1.02	0.66	19
C34	Stakeholder	Top Management support for and commitment to sustainable construction	3.58	0.97	0.66	20
C8	Operational	To increase operational flexibility	3.58	0.99	0.72	21
C32	Stakeholder	As a way to respond to pressure from employees and shareholders on sustainable practices	3.54	1.06	0.65	22
C18	Institutional	Legislation (Acts, Decrees, Edicts)	3.54	0.83	0.65	23
C7	Operational	To achieve improved customer orientation and service	3.54	1.17	0.71	24
C9	Operational	To achieve increased innovation	3.54	0.95	0.71	25
C20	Institutional	Government Policy via legislation on Sustainable Construction	3.54	0.95	0.71	25
C13	Operational	Attitudinal change	3.48	0.92	0.67	27
C31	Stakeholder	As a way to respond to pressure from clients for sustainable construction	3.46	1.14	0.64	28
C29	Stakeholder	As a way to create jobs for local communities	3.46	0.98	0.64	29
C2	Financial	Achieving lower costs of initial capital investments	3.42	0.99	0.68	30
C3	Financial	To achieve life-cycle cost reduction	3.40	1.12	0.65	31
C14	Operational	Improved sustainable design of projects	3.40	1.08	0.65	32
C16	Institutional	In response to environmental conditions	3.38	1.13	0.68	33
C21	Risk	In order to share risks arising from adoption of sustainable construction	3.38	1.13	0.68	34
C10	Operational	To obtain access to Building Information Modelling (BIM)	3.31	1.01	0.66	35
C5	Financial	Improvement in Sub-contractors' profit margins	3.19	0.85	0.64	36

Driver code	Driver category	Drivers of Project Managers' performance	Mean Score	SD	RII	Rank
C4	Financial	Construction operatives are able to make better money	3.00	1.22	0.55	37
C22	Risk	As a way to transfer risk arising from adoption of sustainable construction	2.96	1.18	0.59	38

Summary of Findings

The following is a summary of the main findings arrived at in this study after conclusion of the analysis of data and subsequent discussion of the results. The findings are presented in line with the three objectives of the study.

1. Project managers on residential estate projects perceive themselves as highly competent in ten competencies which include Interpersonal skill, Quality management, and Document and contract administration. PMs are moderately competent in six competencies that include Budgeting, Risk management, and Emotional intelligence.
2. The traditional 'iron triangle' of project performance indices (cost; quality; time) are most influenced by technical competencies such as Budgeting, Document and contract administration, and Procurement management. The strongest influence of such competencies was found to be on project quality performance.
3. The strongest driver of project managers' performance on residential estate projects is the 'commitment of project stakeholders to sustainable construction'. This study has identified 26 drivers that could influence the performance of project managers.
4. 'Lack of teamwork', 'Poor leadership skills', 'Poor understanding of client's brief with respect to Sustainable Construction', 'Inconsistency in policies regarding Sustainable Construction', and 'Corruption (by all stakeholders; government, client, consultants, contractors, suppliers, end users, host communities)' have been found to be the most influential barriers to improvement in the performance of project managers.
5. A total of 29 factors that influence residential estate projects were identified as key to improvement in the performance of project managers. The 29 factors were split into seven categories, which included Attitude, Finance, Government Policy, Knowledge,

Management, Stakeholder and Technology. There were 8 factors under Attitude, 6 each under Finance and Management, and 4 under Government Policy.

Conclusion

This study has identified 26 drivers that could influence the performance of project managers; the strongest of these was the ‘commitment of project stakeholders to sustainable construction’. Of the 45 barriers that were identified, ‘Lack of teamwork’, ‘Poor leadership skills’, and ‘Poor understanding of client’s brief with respect to Sustainable Construction’, were the most influential. The strategy adopted for enhancing the performance of PMs identified 29 key factors that were split into seven categories - Attitude, Finance, Government Policy, Knowledge, Management, Stakeholder and Technology.

Recommendations

This section sets out recommended actions that are considered necessary based on the findings arrived at in this study after of data analysis and discussion of results.

1. Continuing professional development of Project Managers is recommended in order to hone and improve their competencies in areas where some weakness has been identified in this study. Such areas include Budgeting, Risk management, and Emotional intelligence.
2. Significant unplanned extensions in completion times are bound to have some negative effect on the cost and quality performance of projects. Project Managers of residential estate projects should pay greater attention to managing the schedule of such 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.
3. One of the ways in which the performance of project managers on residential estate projects could be enhanced is by ensuring that there is total ‘commitment of project stakeholders to sustainable construction’. Improved performance by Project Managers will in turn drive improvements in project performance.

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LOCAL ECONOMIC DEVELOPMENT (LED) AS PANACEA FOR SUSTAINABLE NATIONAL ECONOMIC GROWTH IN A DEVELOPING ECONOMY: EVIDENCE FROM NIGERIA.

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ABSTRACT

Evidence from extant literature revealed that local economic and institutional capacity can flourish from the bottom-up and provide solutions that guarantee sustainable economic growth and socioeconomic turnaround. In Nigeria, local economic development has continued to be a mirage due to weak capacity of the local authorities. Therefore, this study examined the contribution of local economic development to national economic growth in Nigeria. The study adopted mix-method research design to collect data primary and secondary data. Data were collected through structured questionnaire, and from the World Bank and Nigeria Bureau of Statistics. Data collected were analysed using descriptive and inferential statistics. The result of hypothesis one revealed that the presence of attractive economic conditions have significant influence on higher economic activities ($\text{AdjR}^2 = 0.921$; $F\text{-statistic} = 106.226$; $p < 0.005$), while the result of hypothesis two revealed that positive influence of economic conditions at the local level leads to enhancements of national economic. ($\text{AdjR}^2 = 0.717$; $F\text{-statistic} = 0.729$; $p = < 0.005$). The study concluded that local economic development has significant influence on national economic growth in Nigeria. The study recommended that government should develop and implement tailored strategies that will enhance the capabilities of the sub-national level economies, directed toward allowing each territory to reach its economic potential and make them attractive to people to make investment and pursue business activities.

Keywords: Local Economy, National Economy, Development, Sustainability, Nigeria.

1. Introduction.

Economic growth is the most powerful instrument for reducing poverty and improving the quality of life. Both cross-country research and country case studies provide overwhelming evidence that rapid and sustained growth is critical to making faster progress towards the Millennium Development Goals (Bloeck et al., 2019; Singh & Chudasama, 2020; Page & Pande, 2018). However, globalisation and decentralisation are causing changes to the process of formation and distribution of economic incentives and activities, and leading to a more heterogeneous economic landscape (Dicken, 1998; Rodriguez-Pose & Tijmstra, 2009). Thus sustainable economic growth now demands holistic strategies that cut across various territorial economic units and sectors of a nation. Though national policies have enormous role to play in promoting economic growth and employment, as most of the policy options of national governments have profound impact on overall economic growth, and the general

development prospects within a nation, however, they do not address the problems of specific territories (Blakely and Bradshaw, 2002). Where national development policies target a specific region or locality, they are often focused on improving infrastructure or diverting economic activity away from one area in favor of another. Many a time, such policies do not match local capacities, nor are effective in meeting local needs. As a result governments have failed to use them to full advantage of regional and local territories (Rodríguez-Pose, 2002). An uneven economic landscape is a national problem, not simply a local one, as it concentrates a country's competitive advantages in too few places, while leaving large swaths of the country underperforming their economic potential. These are twin costs to the extreme imbalance in economic development with the country

Equitable economic growth requires strategies to reduce the disparities that exist in skills, employment, economic performance and many other social issues across the nations, regions, sub-regions, localities, and neighborhoods, particularly in developing country like Nigeria. A successful strategy to promote rapid and sustained economic growth is combining growth promoting policies with policies that allow the poor to participate fully in the opportunities unleashed and so contribute to that growth. Consequently, the traditional national top-to-bottom development strategies will be inadequate to tackle economic development problems (Shannon, 2018; Rodriguez-Pose &Tijmstra, 2009). The flop of traditional strategies has inflamed a rethinking of how development problems can be addressed, and the need for complimentary efforts of all levels of government in a nation (Nel, 2001). An economy based on central planning can lead to arbitrary and wasteful criteria for allocating resources (Espinosa, 2021; Huerta de Soto, 2010), hence there would be no sustainability of growth and development (Espinosa et al., 2021). Resilience national economic growth involves nurturing inclusive, sustainable and burgeoning local economies, which is capable of providing opportunities to people to live and work, and which is attractive to investors for investments. Local economic development approach underscores the importance of national, regional and local governments' complimentary roles in economic development of a nation, as no level can effectively provide support for economic growth and development without the contribution of the others (OECD, 2022).

Essentially, the productivity of an economy depends on how it competes to upgrade the sophistication and productivity of factors. As argued by Florida (2005), any locations which offers a quality of life and attractive to creative people will become the new centers of economic competitiveness. Local economy holds a trove of economic potentials, which makes local economy development strategies to have indispensable cross-cutting role in achieving this (Chen, 2020). Creating sustainable local economic development is a veritable mechanism of enhanced national well-being (United Nations (UN), 2009). Whereas, its absence imposes adverse and severe social and economic problems such as; lack of quality human capital, higher expenditure on healthcare and education (Hussain et al., 2017), lower economic growth, and increase unemployment (Agarwal et al., 2009), with a resultant devastating impact on quality of life and living standards, for the people in the rural regions. Investment in local economic development strategies is a crucial mechanism to improve the social capital of the rural populace (Knapinska& Sinski, 2022; Prosperi et al., 2022; Wang et al., 2021), to access resources and positively raise productivity and income at the local level (Wahid et al., 2016), and integrate the rural people into the globalization drive, thus empowering them to contribute meaningfully to national economic performance (Aksentijevic et al., 2021), reduce the disparities between developing and lagging areas, due to imbalances and spatial differences, increase the contribution of locally generated jobs and businesses to a country's growth, increase the overall private sector investment, and enhance the clarity, consistency and conviction in the application of local economic strategy (OECD/Mountford , 2009).

1.1 Statement of the Problem

The need to actively deploy strategies for economic development at the local levels have become crucial in development narratives as three quarters of the world impoverished live in the rural areas (Akpan, 2012; UN, 2018).

Local economies, especially in the developing countries have not been extended the desired social support for quality living and empowerment for transformational development. Economic development at the local regions is mostly framed as activity inherently different

from economic growth and development generally (Moses et al., 2017). Local policies are mostly targeted at service delivery rather than economic development initiatives, while national government have always fail to recognize the centrality of local governments in implementation of national economic policy. This has often resulted in policies and institutions that are not well integrated with national development programmes. Local economic development issues has always been analyzed through the broad based national economic framework, without considering the distinctive features of local economy and actors. In addition the stakeholders perceive that economic development at the local level depends on the economic policies and interventions solely implemented at the central level.

As a result of the above mentioned factors, majority of the local governments in Nigeria have low administrative and fiscal capacity, and lack resources and fiscal capacity to carry out policies to support development of local economy (Adetiba, 2017). The rural local government and smaller urban councils in Nigeria have weak, declining economic bases, with high level of unemployment and under-employed inhabitants, in contrast to many of the metropolitan local government areas which have relatively prosperous economies connected to the global economies. This has a negative effect on productivity, revenue mobilization and industrial growth, with the consequences being felt at all levels of government. Gaps in key public service delivery between the rural and urban local government areas are widening, and this is causing depopulation of the rural areas, and downward movement of people, due to huge migration of people from rural areas to the cities.

As a consequence, the local economies are grappling with negatives economic consequences, which have complicated improvement in the quality of life and the enhancement of the socioeconomic capacity of the local economy (Adelabu, 2019). Nigerian economic prosperity is under threat as the widening inequality, social exclusion, unemployment and low productivity within and across regions challenge the nation's competitiveness. Furthermore, the nation is facing extreme shortages in food and materials supply, deteriorating infrastructure and other shocks that is disproportionately affecting the local economies and the populace, thus challenging the nation's collective ability to adapt and main economic stability. The geography of the nation's economic growth and opportunity need to be

remolded to marshal the nation's economic assets spread across the nation's geopolitical regions for economic sustainability, rather than allow the nation's current economic policy of focusing on urban development fuel more economic winners and losers from these dynamics. Therefore this study examined the level of government investment on local economic development and its effect on national economic growth.

2. Literature Review

2.1 Conceptual Review

2.1.1 Local Economic Development

Local economic development is a series of tailor-made approaches for the development of sub-national areas. Local economic development champions a development approach targeted at increasing local economic potential and sustainable employment through giving local governments the tools to devise locally tailored strategies in cooperation with local, regional, and international stakeholders and actors. It has emerged as a complementary development strategy that could potentially provide opportunities for growth to all areas. There is not one standard definition of what LED is, according to Shannon (2018) and Trinajstić et al., (2022), local economic development describes the synergy effect of multiple processes initiated and implemented by many actors to provide enhanced living conditions at the local level. It is a concept derived from the bottom-up management approach, proposed in response to the failure of the traditional top-bottom approach, which failed to reduce differences and under-development. The OECD (2013) defines local economic development as a cross cutting and integrated activity where the physical development of a place is linked to public service, place management, and wider drivers of change such as employment, skills, investment, enterprise, innovation, productivity, quality of life, and positioning

According to Unilag (2015), it is an emergent development paradigm in our contemporary era of globalization and decentralization that will enable local decision-makers and citizens to gain an increasing say over economic and social development in the localities in which they live. Zaaijer & Sara (1993), define it as a process which affords local government and/or community based groups manage their resources, and enter into partnership arrangements with the private sector, or with each other, to create new jobs and stimulate economic activity

in an economic area. According to Aksentijevic et al., (2021), local economic development is the process to build the capacity of defined area to improve its economic future and peoples' well-being, by using local resources optimally, thereby contributing to job creation, positive entrepreneurial environment, and better quality of life for local populace, Local economic development links a location to the world economy to attract investment by providing a climate attractive to international investments, and enhancing the role of private sector with limited role for the state (Development Bank of Southern Africa (DBSA), 2000).

2.1.2 Sustainable Economic Growth

Economic growth is the process by which an economy expands its production and consumption opportunities over time. It is the means by which output of goods and services are increased, in addition to the creation of new commodities that are either directly consumed or used as inputs for production of other goods (Goldin & Winters, 1995). Sustainable economic growth means maintaining growth without creating economic problems or complications. It is the practice of supporting long-term economic growth without marginalizing any section or sector of the economy (Aytekin, 2019). Sustainable economic growth reflects an improvements in the material standards of living, even though the share of such improvements accruing to individuals may vary sharply across society. Generally, the acceptable measure of economic growth is the change in real per capital income over time. Thus sustained economic growth can be measured as the long-run tendency of the per capital income of a nation to expand over time (Santanu, 2010). Sustained economic growth provides the means for increase income for the citizens and corporate organizations, profitable business opportunities for the people, and tax revenues for investment in public facilities and infrastructure, which are necessary to support continue growth.

2.2 Theoretical Framework

2.2Location Theory

Location is one of the important factor of any industrial development. Location, not only defines our reach to market but also labour cost, cost of energy, availability of suppliers, communications, education and training facilities. (Scott & Storper, 2007). But due to modern technologies as the death of distance is stated the significance of location is diminishing. Location theory seeks to explain the distribution of activities in space. It is aimed at identifying the factors that influence the location of individual activities, the allocation of different areas of territory among different types of economic activities (Capello, 2011). Space influences the working of an economic system, and can act as source of economic advantages or disadvantages in term of endowments of production factors. Productivity of an economy essentially depends on how it competes to upgrade the sophistication and productivity of factors. The most important sources of productivity are created by converting a local endowment and assets into intellectual capital and added value. As argued by Florida (2005), any locations which offers a quality of life and attractive to creative people will become the new centers of economic competitiveness. By successfully rooting economic activity in the local social and economic fabric, territories have the potential to become a source of vitality and strength within the national economy (Storper, 1997). However, if a locality fails to engage with the challenges posed by globalization, it runs the risk of being marginalized.

2.3 Empirical Review

The development of local economy is a foreground process for a nation's socio-economic policy, and is vital to the economic, social and environmental viability of nations (OECD, 2022). Most empirical studies have defined LED processes (Blakely & Leigh, 2009; Helmsing, 2011), but there are only a few attempts to measure its outcomes. In its assessment of outcomes of local economic development, the OECD (2011), noted that the development process of local economy has a profound impact on the life of the dwellers, and great potential for national economic growth, through the enhancement of people well-being, employment generation, provision of materials for industrial support, and reduction in rural-urban migration. The World Bank (2019), attributed the diversification and rise in economic prosperity of Malaysia economy to her emphasis on local economic development approach

and ensuring that the locals have access to training, skill acquisition and other resources to start-up small businesses.

Rodriguez-Pose & Tijmstra (2009), identified that local economic development strategies is a viable and valid way to tackle development problems of economies around the world, while, Storper, (1997) and United Cities and Local Government in Africa (UCLGA) (2016), observed that implementing strategies that strengthen the local social and economic fabrics enhance the potentials of local economy to become a source of vitality and strength and catalyst for promoting economic growth from the grassroots to the national economic development. Rodriguez-Pose and Tijmstra (2009), conducted a study across five Latin American countries, to examine the influence of local and regional economic development strategies (LED) as necessary and viable complement to traditional development strategies in the face of radically changing economic conditions. The main conclusion of the study was that local economic development strategies is becoming a valid complement to traditional top-down strategies in order to deliver sustainable development, that and it many cases may deliver greater economic efficiency by mobilizing resources that otherwise may have remained untapped and a large number of social benefits are derivable, by promoting voice, participation, and sustainability across territories where institutional conditions have been far from ideal.

Ma (2005), observed that China economy is a classic example of an investment-led economy, as the fast growth of China economy was supported by increase in local economic development through the establishment of small entrepreneurship ventures, provision of training and capacitation workshops. Rodrik (2014), asserted that approach of local economic development as a central economic development initiatives in India through the implementation of robust programs and oversight mechanisms caused a rapid growth of India's GDP for most of the last two decades leading to rising per capital incomes and reduction in absolute poverty. Diseko (2014), noted that the emphasis of United States government on local economic development led to staunch support for local economic development projects that support job opportunities and the key in youth entrepreneurship empowerment and creativity. The Gulf Times (2017), observed that Qatari economic rise

trajectory is due to the fact that the government has continued to support, and empower small and medium sized projects, as a response to her current and future needs with the best international quality standards to support the national economy.

Pavel and Moldovan (2019) assessed the main factors which influence the level of LED in 398 communes from the North-West development region of Romania during the 2007–2014 period. Using a linear regression model, the authors confirmed that higher level of education, location (or proximity to a big urban area) and direct connection to road Network were the most important and statistically significant predictors for the level of LED. Triegaardt, (2007), concluded that the phenomena changes in global economy have increased the status of locality in the global economy, leading to rising importance of local and community decision-making in social and economic spheres. Li et al., (2015) developed an index to evaluate the correlation between the rurality index and major socio-economic and geographical indicators at county level on economic growth in China, using national census data for 2000 and 2010. The study reported that counties with lower rurality index have better economic performance than counties with a higher rurality index. This the study attributed to geographical and economic marginalization of counties with high levels of rurality index.

Pisani and Micheletti (2020), concluded that better competitive infrastructure leads to improvement in local economic development as it makes rural areas accessible from several urban regions, to attract investment and markets suitable for rapid socio-economic growth of the local. This aligns with the findings of Shiferaw (2017), noted that infrastructure development has induced improved aggregate productivity and substantial economic growth, and contributed considerably to local economic development, and Rogerson (2003), who observed that a critical step to expand the asset base of the poor is to improve on their limited access to range of basic public amenities and infrastructure services. Therefore expanding the delivery of infrastructure services in localities of the local economies is an important local economic development role to support economic expansion and alleviate poverty.

Thadaboina (2009), showed that investments in Information Technology and Communication networks, databases and personal computer operating courses reduced commercial costs for

the rural population, reduced the time and costs of accessing public services, while also increasing productivity in the agricultural sector and improving the overall quality of life. Thus, the development program analyzed by Thadaboina succeeded not only in increasing the employment rate of the rural population, but also provided spill-over benefits, such as increasing the level of participation and involvement of the population, facilitating access to health, education and financial facilities. Edeh et al., (2017), relied on review of extant literature and content analysis on the need for re-engineering rural economy through the provision of social infrastructure in Nigeria. The study revealed that poor condition of education, piped water, housing and healthcare facilities is inhibiting economic development at the local level with an attendant negative impact on sustainable national economic development.

Agriculture has a key role to play in local economic development process, on one hand due to the capacities of the farming population to promote productivity growth, and on the other, due to the government's ability to support the rural farmers with broad based modernized agricultural strategies that attract foreign investments that complement rather than displace local firms. Evidence from localities that have experienced broad based agricultural modernization have proven that this can be a fruitful strategy in combating poverty. Sharma (2007), found empirical evidence showing that growth in the agricultural sector not only reduces rural poverty, but has a positive effect in urban poverty as well. Especially since urban growth often fails to benefit the poor as well as does little to alleviate rural poverty this stresses once more the developmental importance of agricultural modernization. Sertoglu et al., (2017) found that in the short run, a positive statistical relationship exists between natural logarithm value of agricultural output and real gross domestic product (RGDP). This shows that agriculture is a viable source of economic growth in Nigeria. The study also found a long run relationship between all variables, and that the neglect of the agricultural sector for the oil sector in Nigeria has negative long run implication with RGDP.

Abula and Ben (2016) examined the impact of public expenditure on agricultural output on economic development in Nigeria using annual time series data spanning 1986 to 2014 and established that agricultural output plays significant impact in Nigeria's economic

development. The results of impulse response function in support of the variance decomposition analysis showed that per capita income responded positively to shocks in agricultural output throughout the ten-year period, while the response of per capita income to shocks in public agricultural expenditure was negative in the first two year period but became positive throughout the last eight periods. Chinedu et al., (2018) examined the impact of sectoral spreads of government expenditure on economic growth in Nigeria. Results from the study established that government expenditure on agriculture and defense had positive significant impact on economic performance in Nigeria while government expenditure on transportation, communication, health and education were not statistically significant. This result implied that expenditure on agriculture improves the economic performance of the Nigerian economy. However, Valdes and Foster (2010), obtained evidence that agriculture does contribute to poverty alleviation, but not sufficient alone to sustain economic development.

On the other hand, Christiaensen and Demery (2007), provided evidence that reinforced the importance of modernizing agriculture by the experiences in areas that have failed to make this transition. The authors found that in most of Sub-Saharan Africa the failure to promote productivity growth in the agricultural sector has been accompanied by high levels of rural poverty and food shortages. Wong (2002), in the assessment of indicators for LED in the districts/local communities development North West and Eastern Regions of England, using multiple regressions and factorial analyses, found that location (accessibility, connectivity, and proximity) and the quality of the human resource (the skills and qualifications of the workforce) of a locality are important for LED capability enhancement. Rives and Heaney (1995), focused on the impact that investments in local infrastructure have on LED or local rural development of 178 communities in Iowa (USA) by building an index consisting of indicators structured in four main dimensions: economic development, infrastructure, location and education. The study confirmed the existence of a link between infrastructure and local economic development. Furthermore, public policies aimed at ensuring infrastructure maintenance works (especially highways that ensure the connectivity of small communities) can then further increase LED.

Ultimately, evidence from extant literature suggest that the key to local economic development success is creating an environment where investors are encouraged to take risks, operate in a flexible environment which permits them to react quickly to market changes, and to adopt innovative problem solving approaches. Fortunately this type of environment can exist in the national, regional and local economies with the presence of favourable economic conditions.

3 Methodology

The study focused on the effect of local economic development strategies on national economic growth in Nigeria. The study used existing economic conditions at the local government areas as the independent variable, while agricultural productivity was the dependent variable since agriculture is the primary occupation at the rural level. The study adopted mix-method research design to collect data primary and secondary data. Primary data on the prevailing economic conditions and their impact on economic productivity were collected from five local government areas in each of the six states of the South-West geopolitical region through structured questionnaire, while secondary data on the productivity of agriculture in Nigeria for the period from 1991 – 2020 were collected from Nigeria Bureau of Statistics. The data collected were analyzed using ANOVA and regression model to ascertain the predictive power of the model.

In accordance with the objective of this study, the following hypotheses were formulated

- i. Positive local economic conditions does not significantly lead to local economic development
- ii. Local economic development does not significantly contribute to national economic growth.

4 Data analysis and Results

Table 1: Descriptive Statistics

N	Minimum	Maximum	Mean	Std. Deviation
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Local conditions	Economic	30	46.12	53.52	49.8870	2.49313
Local Development	Economic	30	30.90	63.00	49.0310	10.57158
National Growth	economic	30	7.80	37.70	20.9550	11.17386
Valid N (listwise)		30				

Source: Researcher's own computation with IBM SPSS (2023)

Table 1 presents the results of descriptive statistics on local economic development and national economic growth. The local economic conditions 46.12 to 53.52, demonstrating a relatively narrow spread with a mean of 49.8870 and a standard deviation of 2.49313. Local economic development exhibits a broader range, varying from 30.90 to 63.00, suggesting greater variability, with a mean of 49.0310 and a standard deviation of 10.57158. Meanwhile, national economic growth ranges between 7.80 and 37.70, indicating a considerable dispersion, with a mean of 20.9550 and a standard deviation of 11.17386. These statistics revealed a comprehensive overview of the central tendencies and distributional characteristics of the variables, offering valuable insights into the dynamics of local economic conditions, local economic development and national economic growth within the context of the study

4. 1 Test of Hypotheses

- i. **Hypothesis One:** Local economic condition does not significantly influence local economic development in Nigeria.

Figure 4.1 ANOVA^a

Model	Sum of Squares	Df	Mean Square	F	Sig.
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1	Regression	1024.936	1	1044.996	106.226	.000 ^b
	Residual	78.700	8	9.837		
	Total	1103.636	9			

a. Dependent Variable: Local Economic Development

b. Predictors: (Constant), Local Economic Conditionality

Figure 4.2 Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	-194.660	20.934		-9.294	.000
	Local economic conditionality	4.222	.419	.964	10.307	.000

a. Dependent Variable: Local Economic Development

Figure 4.3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.964 ^a	.930	.921	3.13648

a. Predictors: (Constant), Local Economic Conditionality

Source: Researcher's own computation with IBM SPSS (2023)

The ANOVA result revealed a robust significant relationship between local economic condition and local economic development. At the level of significance of 0.00 and with degrees of freedom 1 and 8, the F-statistics is 106.226, while the p-value of the F-statistics is < 0.000, which is less than the 0.05 adopted level of significance. Therefore, the study

rejected the null hypothesis, which implied that the condition of local economic in Nigeria significantly influence the level of local economic development in Nigeria. The value of the coefficient of multiple determination (Adjusted R^2) of 0.921, suggests that approximately 92% of the variability in the level of local economic development within Nigeria can be explained by existing economic conditions of the local areas.

Hypothesis Two: Local economic development does not significantly contribute to national economic growth in Nigeria.

Figure 4.4: ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	78.467	1	75.488	.729	.034 ^b
	Residual	940.336	8	116.292		
	Total	1018.803	9			

a. Dependent Variable: National Economic Growth

b. Predictors: (Constant), Local Economic Development

Figure 4.5: Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	104.982	72.009		1.486	.176
	Urbanization Rate	-1.162	1.442	-.274	-.806	.044

a. Dependent Variable: National Economic Growth

Figure 4.6 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
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1	.734 ^a	.810	.717	3.24568
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a. Predictors: (Constant), Local Economic Development

Source: Researcher's own computation with IBM SPSS (2023)

The ANOVA result revealed a robust significant relationship between the predictor variable, urbanization rate, and the dependent variable, poverty rate. At the level of significance of 0.034 and with degrees of freedom 1 and 8, the F-statistics is 0.717, while the p-value of the F-statistics is < 0.034 , which is less than the 0.05 adopted level of significance. Therefore, the study rejected the null hypothesis, which implied that local economic development significantly contributes to national economic growth in Nigeria. Considering the value of the coefficient of multiple determination (Adjusted R^2) of 0.717 indicating that approximately 72% of the variability in the national economic growth in Nigeria can be explained by local economic development.

5 Discussion

Local economies have crucial role to play in national economic regeneration and neighbourhood renewal. As indicated by the results of the study, there are opportunities for local economic development through logical strategic planning and partnership of all levels of government and human capital development to play a strong role in developing national economies. This corroborated evidence from extant literature that flourishing local economic conditions has the capacity to provide solutions that guarantee sustainable economic growth, quality employment, and a socioeconomic turnaround of nations across the world. There is a growing consensus that to provide the foundation for sustainable national development, efforts need to be focused on stimulating a well-coordinated long-term national, regional and local economic development (OECD, 2022). Sustainable economic growth process hinges on inclusive development of the economy, focusing on equal distribution of development across the regions and sectors (Johnson & Anderson, 2012).

Economic regions now form the basic unit of global competitiveness which is founded on identification and leveraging of a unique combination of location human and material assets.

Adapting development strategies to local institutional conditions, while at the same time promoting local capacity building may be the way to deliver greater and more sustainable development to territories that until recently were considered to be either declining, basket cases, or too small or isolated to figure in national development priorities. An impetus for creating competitiveness in local economy is engaging local assets to create home grown economic opportunities. The most important sources of productivity are created by converting local endowment and assets into intellectual capital and added value. Economically developed locations will attract investments, while the lagging areas will remain innocuous and cutaway from global production network.

Thus, both the federal and states governments in Nigeria should focus on strengthening the local economies as a priority in national economic development strategies, in order to foster the socioeconomic development of the rural areas as a precursor to national economic development. Government can use improved policies and investments to better localities and regions to adapt to external forces, and unleash the economic potentials of the local and regional levels to adapt and keep pace with changing rules. This will aid promising and endowed localities to create a valuable window to advance federal efforts to expand economic opportunity. Governments spending is a major source of investment in economic growth and development. Governments at the federal and state level invest huge amount of money annually in different sectors of the economy for economic development. Sparing a fraction of this amount for technical assistance, training, planning, capacity building and operational support for local economy and their authorities can strengthen local economic to support changes in state or national policies that affect rural and urban strategies and outcomes (Dumenu& Obeng, 2016; Moskalenko &Yevsieieva, 2015).

Economic losses from low quality human capital, paucity of fiscal resources uncoordinated economic policies leading to backwardness of the rural areas extend beyond the vaunted urban-rural divide. It is engrained into the sub-regional and regional and national context, and has become critical to the extent that the whole country has a great benefit to reap from coordinated economic development initiatives channeled through global, national, regional and local levels. Nigerian economy in the past decades strives on the agricultural sector. The

sector in the early 1960's served as the key driver for growth and development. Agriculture has a key role to play in local economic development process. On the one hand, this is linked to the capacities of the farming population to promote productivity growth that promote productive forward and backward linkages with other economies. On the other hand, it is related to the government's ability to support the rural farmers with broad based modernized agricultural strategies that attract foreign investments that complement rather than displace local firms.

Evidence from localities that have experienced broad based agricultural modernization have proven that this can be a fruitful strategy in combating poverty. Investment in agriculture is one of the most effective strategies for creating employment, reducing poverty and hunger and promoting sustainability (FAO, 2012), and as observed by Gunnar Myrdal (1984), the battle for long-term economic growth will be won or lost in the agricultural sector which is the popular occupation of the local populace. However, there is growing evidence that the share of agriculture investment in government expenditure is declining. Improving the production capacity of agriculture in Nigeria through productivity increases is an important option since agriculture represents an important sector in the economy. Agricultural sector provides livelihood directly and indirectly to a significant portion of the population, particularly the rural populace. Thus, a growing agricultural sector contributes to both overall growth through provision of the industry with raw materials and food for the population for poverty alleviation. Therefore governments need to create the right conditions and institutional frameworks as a foundation upon which to encourage investment, innovation, and economic growth

Adequate and timely investment is of paramount importance as a limiting factor to productivity because of the alarming decline trend of agricultural productivity. The decline in public investment in agricultural modernization should be of huge concern because public investment in infrastructure, human capital resources, research and development are necessary conditions for higher agricultural productivity. Public investments is also fundamental to promote technology adoption, stimulate complementary on-farm investment and input use, processing and storage of produce, and for marketing of produce (Feder et al.,

1985; Nelson, 1981; Wozniak, 1989). Complementarily, the structural change hypothesis assumes that the process of development is facilitated in an economy, when dependence on the agricultural sector is modernized and competitive, to be able to serve as catalyst for economic growth. Since most citizens live in the rural areas and depend on agriculture in the country, it has become apparent that the development of the sector can promote economic development. Thus the agricultural sector needs to be developed further to increase the income of the rural populace, provide food and raw materials to the industrial sector. Recent developments in regions that have experienced broad based agricultural modernization have proven that this can be a fruitful strategy in combating poverty (Pingali et al., 2019; World Bank, 2019b)

Economic development of a nation requires a comprehensive balancing of the economic goals of a nation, and usually premised on coordinated development strides across all levels of government within a nation. Therefore, governments must take measures and investments options that will improve the subnational and the national economies, and place the economies on the better path for sustained growth, now and the future (Jiroudkova et al., 2015). Agriculture and industrialization tend to complement one another, in part, this is because industrialization process involves the raw materials from agriculture, while industrialization has the higher potential to support growth by endearing innovation to support dynamic economies of scale, attract external economic factors that can enhance agricultural development and support the nations continued growth trajectory. In the long term, booming industrial and service sector empowered by agricultural productivity are required to sustain the growth trajectory of the entire economy, boost employment and eradicate poverty. Thus, in the long term, it is imperative that governments design and implement strategy that leverages the dynamic synergies between agriculture and industry (Barrie et al., 2017; Coomes et al., 2017).

6 Conclusion and Recommendations

The heterogeneous nature of the global economy, has rendered the traditional top-down economic growth and development policies of the nations' to be less effective in delivering sustainable development, as many of the national development policies have not been

effective to address the key territorial development problems, but rather have created economic and social inequalities that have contributed to exacerbate developmental problems with far reaching negative consequences on national economies. Taken Nigeria as a whole, the development problems today are more acute than they were few years ago. However based on the findings from the study, and recorded successes of local economic development on economic growth across the world, local and regional initiatives have proved to be a valid strategy for socio-economic growth and development. The study concluded that solutions to creating sustainable and equitable economic growth in Nigeria can be realized from the transformation of her subnational levels economies. This approach will allow the country to harness the economic assets that cluster in specialized ways across localities and regions within the country to build up homegrown capabilities, through the mobilization of economic potential, of local and regional initiatives, that otherwise would have remained untapped and contribute to make a fuller use of existing economic potential than traditional top-down policies.

Consequently, the study recommended that analytical attention need to be focused on indigenous development and enhancement of local capacities to generate self-sustaining economic growth. Thus, government in Nigeria need to formulate, and faithfully implement policies and programs that will strengthen the political, legal regulatory and economic frameworks of the local territories, appropriate to provide high payoffs from productive initiatives that will be put in place to develop an environment that attract stakeholders and key resources to the local territories. The policies and strategy must recognize that each territory has its own mix of constraints, challenges, and opportunities to stimulating sustainable economic growth. The policy should further focus on development of key resources in the local territories in consonant with their peculiarities.

7. Implication of the Study

As most citizens live the rural local government areas, and participating directly or indirectly on agricultural activities in Nigeria, allocation of more budgetary expenditure for the development of the local government areas, particularly the rural localities can reduce the rural-urban drift retain the rural populace in their domain, attract more investment into the

areas thereby promoting economic development, increases the per capital income, provide food and other commodities to the domestic sector, and possibly increase food and raw materials supply to the international economy.

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TECHNOLOGICAL INNOVATION IN TEACHING AND LEARNING IN NIGERIAN SCHOOLS IN THE 21ST CENTURY

BY

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ABSTRACT

This paper tries to examine technological innovation in teaching and learning in Nigerian Schools in the 21st Century. Over the years, teaching in schools has been done in the traditional way while learning by students and teachers alike was before now facilitated by traditional means. If the situation persists, how the nations' educational system can compete with the rest of the world is a mirage. Lately, the narratives have changed with advancement in technology which have permeated every aspect of human life and economy as well. It thus created room for convenience, attractiveness and without no monopoly of knowledge as was the case in the past. The duo concepts of teaching and learning are interwoven and complex but central to the business of the educational system of any nation, including Nigeria. Teaching and learning are the embodiment of the nations' educational system upon which other sectors of the economy relied upon. It is also the driving force upon which the objectives of our schools are accomplished. The paper shall therefore discuss the concepts of technology, curriculum innovation, teaching and learning; technological tools for teaching and learning in schools, use of technology in teaching and learning, importance of the use of technology in teaching and learning in schools and challenges to the use of technology in Nigerian schools. It further proffer solutions to the challenges identified such as provision of alternative source of power supply, provision of technological tools to teachers and students at subsidized rate, mandatory provision of tech. tools before resumption to schools among others.

Keywords; Innovation, Learning, Schools, Teaching, Technology

Introduction

Innovation is inevitable in the human race as no one, group or organization wants to remain static at a position for too long. This is no surprise why human beings tried on daily basis to acquire knowledge, skills and values of one form or another to better selves, communities and the nation at large. This can be obtained through formal or informal education, depending on the choice most accessible by people considering their meagre resources at their disposal. In the context of formal education, they are obtained in formal schools specifically permitted for such purposes. These schools are like military barracks where students come in from time-to-time and leave at the expiration of their stay over there. One thing is thus certain, to learn under the tutelage of their teachers who have been

professionally trained to do so. Though, teaching and learning across our schools at different levels have slightly changed from what it used to be in the past. At the moment, teaching and learning processes are being facilitated through technology either online or offline and at ease for both the teachers and students alike. It is a testament to advancement in technology which has over the years transformed human society, making the world a global village in the present information age.

Before now, teacher - chalkboard method had facilitated what teachers do in the class while students on their part have relied heavily on copied lesson notes and available text books for their assignments. In today's world however, the use of Information and Communication Technology (ICT) has now become an integral part of every human society (Nwachukwu, 2006). This development has challenged the traditional role of the education sector in human society. Now, the education industry is faced with the challenge of equipping the learners with technology and information literacy, problem solving skills, critical reasoning, and the ability to use digital technology in accessing and utilizing information for problem-solving in addition to knowledge of subject's content in class. Aside this fact, the use of ICTs in Nigeria and Africa countries generally is increasing and dramatically growing by the day. While there is a great deal of knowledge about how ICTs are being used in developed countries, there is no much information on how ICTs are being introduced into schools in developing countries including Nigeria (Beukes - Amiss and Chiware, 2006). The main thrust of this paper was to discuss technological innovation in teaching and learning in Nigerian Schools in the 21st century. To do this however, the structure of this paper has been carefully discussed along the followings:

Concept of Technology

Advanced Learner's Dictionary considers technology as the systematic application of gadgets to delivery of knowledge through a practical task in an industry (say, the field of education). Technology thus supports education through its dynamic, flexible and interactive content. It also provides opportunities for personal learning plan as well as motivates and engages students in learning. Knowledge is made more relevant and applicable to real world situations through the use of appropriate technology most especially in class (Kwache, 2007).

In lieu of this, learners are exposed to various social media such as YouTube, MySpace, facebook, Digg, Computer games, X (formerly Twitter), email, and text messaging, in what appears as technologies to their social life (Zhang and Olfman, 2010). The application of educational technology in the classroom setting improves teaching - learning process and permits teachers as well as learners to interact as human beings in a climate where people control their environment for their own purposes.

Educational technology is essentially referred to as the use of media and equipment in the teaching-learning process. These instructional materials include chalkboard, flannel boards, models and overhead projectors. Technology in education implies video/audio cassette recorder, video cassette, player/recorder, radio, television, telephone and computer. Educational technology implies a systematic approach to instructional design, incorporating alternative methodologies, media and aids with reference to objective in terms of learning content. Educational technology is seen as the application of the principles of technology in solving educational problems. The use of computer in education is traceable to the development of educational technology. The objective of the national policy on computer education launched in 1988 was specifically to expose the learners to:

- (i) Knowledge of computers and their uses in everyday life;
- (ii) The use of computers to facilitate or enhance their learning process and problem solving and;
- (iii) Acquire and develop rudimentary skills like data processing, word processing, record keeping and financial analysis. Notably, computer education programme was planned to improve the quality of teaching-learning in schools aiding technological and socio-economic development of a nation. Technology in education no doubt equips the recipient with the ability to utilize the computer and other digital electronic devices for the purpose of transmitting information technology (IT) from one place to the other.

Concept of Teaching and Learning

Abdellatif (2014) opined that teaching and learning are integrated circles which focuses on what both teachers and students do in class or outside the classroom (reading for learning).

Although, one could sometimes happen without the other. In any way, teaching and learning are two sides of the same coin, so to say. The duo concepts involve the use of strategies which maximize opportunities for interaction in class. The ultimate aim of teaching is to bring about learning via the use of technology. Therefore, a teaching process that does not result in learning is of no use. Without quality teaching, only a limited form of learning is possible. This of course is no surprise that the Federal Republic of Nigeria (2013) states that “No education system can rise above the quality of its teachers”. In some American states, employers even use students’ academic achievement as part of the criterion for deciding teachers’ performance.

Teaching thus connotes imparting knowledge or skill while learning refers to acquisition of knowledge by updating his/her data and the learner’s feedback (Judeh, 2014). The goal achievement of students in the school is reflected in excellent performance. Performance in this study encompasses the full range of activities that would characterize a school as being successful. This would, in addition to students’ academic performance furthermore include well motivated and committed teachers, learner satisfaction and involvement, parental involvement, a clean orderly school environment, qualitative teaching and learning process and strong principal leadership ability. Although, assessment of teaching and learning in Nigeria has not been sufficiently done. Sometimes, only learning is assessed while teaching is left out and vice versa.

In such a situation, it is impossible to have comprehensive data and plausible generalizations about the teaching and learning trends in the school system. There are however, few good learning assessments that tried to ascertain altogether the impact of teachers, school administration, parents and environment on the learning outcome of students to show that all these factors count. This being the case, the major concern of schools is the success or effectiveness of teaching and learning process using any appropriate means available. Though, performance is determined by many other factors just as technology is the focus of this paper. Notably, there are many teaching methods that is available to practising teachers; quick meaning of this is that teaching methods have received different classifications from different teachers. In all fields and to all teachers, the most appropriate method of teaching

therefore is that which can motivate the students and sustain their interest in the course of instruction. It is equally important to note that teaching methods also involves the interaction of the teachers, learners and the subject matter.

Learning on the other hand, has a close connection with teaching because when there is one who is teaching there are students who are learning. Learning is thus a change in behaviour of learners as a result of interaction with environment and a purpose to fulfil had become a necessity. Any activity can be called learning so far as it develops the individual (in any respect, good or bad) and makes him alter behaviour and experiences different from what they would otherwise have been” (Woodworth in Ali and Masih, 2021). Quality learning is extensive, integrative, and generative (Lawson and Kirby, 2012). Based on their studies, they observed that three factors influence the quality of learning. These are dispositions towards learning, conditions for learning, and the learning process.

The learning process is much associated with the approaches to learning. For decades, one of the most persistent problems which teachers have struggled to solve has been how to achieve maximum results with minimum but effective medium of instruction. There has been a need to change our emphasis on teaching by the teacher to learning by the learner. Thus, rather than be a teacher - centred activity, instruction has become learner - centred. Teachers need to ascertain what their students wish to know and how it is relevant to their life and work and how they learn best. Hence, for effective teaching and learning to take place, there must be a correlation between teacher’s instructional strategies and students’ learning styles (Akinbobola, 2011b).

Application of Technology to Teaching and Learning in Schools

Smith (2016) pointed out that there are many ways of integrating technology in the classroom, ways that do not directly involved the use of computers. It was further disclosed that some schools or teachers have adopted or replaced traditional classroom tools with equivalent technology tools to teach. They include:

- White board tools which now exist in different form such as “sketchlot”. It requires the teacher creating an account and then add list of students. The teacher can then assign

passwords to students to enable them join in drawing shared by the teacher. The students can also create drawings and share with their teachers. Another replica of white board is “AWW”. It is also an app that required subscription. One can invite people to see their whiteboard content by sending them the link of their drawing

- “Stoodle” this is free white board tool. It requires the teacher to lunch a classroom. It allows voice capability as a microphone can be used with it.

- Prezi: It is one of the best presentation programme available online. It helps to create zoom presentations. Uses of technology in teaching and learning process are increasing with advancement in technology. Many people are now using the online education platform to get educated. Schools all over the world are increasingly turning their attention to different kinds of technological resources to support and enhance the teaching and learning of the 21st century skills. This is especially so because technological skills have become critical in our daily lives. These skills are needed for success in our rapidly changing and highly competitive world.

Thomas (2004) and Ranga (2004) classified the application of computers and other communication technologies in education into three broad categories: Pedagogy, Training and Continuing Education. The pedagogical applicability of the ICTs is about learning with the support of various components of computer. Olakulehin (2007) emphasized that pedagogic application of ICTs, involves effective learning with the aid of computers and other information technologies, serving the purpose of learning aids, which plays complementary roles in teaching/learning situations rather than supplements the teacher. This means that ICTs can facilitate learning in schools and learning at home on one’s own through methods like modeling, simulation and so on.

The effective application of ICTs has advantage of increasing the learners’ motivation to learn more and desirable attitudes towards actualizing more of ICTs tools. The evolution of mobile technology has also put learning in the palm of both teachers and their learners. Mobile technology refers to mobile devices that include Personal Digital Assistance (PDA), tablets, digital cell phones and ipods. They are self-effacing enough that they have

become useful in implementing different learning techniques and pedagogies (Dale and Povey, 2007; Varis, 2007; Arkorful, Oduro and Abaidoo, 2016). Mobile technology learning, otherwise called M-learning is learning achieved through wireless technology devices that can be pocketed and utilized wherever the learner's device can receive unbroken transmission signals (Attewell and Savil - Smith 2005). Apparently, it is no more sufficient for teachers to use a particular technology or software where students' need constant access to an evolving array of technological tools and activities that will enable them to engage in problem-solving, decision-making, teamwork/collaboration and innovation. The followings can be used or designated to perform the underlisted activities that hitherto promotes teaching and learning in Nigerian schools in the 21st Century.

1. Audio and video devices such as radios, television programmes, DVD, VCD have been in use in the classroom for a long time. Technologies of the 21st century now allow teachers to stream audio over the internet. There are also webcasts and podcasts available over the internet for students and teachers to download. Websites like Youtube also allow teachers and students opportunity to watch on-line videos. Messaging programs such as Skype, Adobe Connect or webcams are used by teachers to interact with guest speakers and other experts.
2. Blogging: These are personal internet journals which allow both students and teachers to post their thoughts, ideas and comments on the website for others to comment on, open discussion or seek opinions. Blogging allows students and teachers to share their thoughts and comments on the thoughts of others thus creating an interactive learning environment (Courts and Tucker, 2012) on-line even when separated by distance.
3. Webcam which are video cameras that streams images through the computer network which could be webcasted to create virtual platforms, In this environment, teachers can give instructions and receive feedback from students.
4. Screen casting: This is a recent trend that allows users to share their screens directly from their browser online so that the viewers can stream the video directly. By this means user can follow the individual's line of thought without ambiguities associated with explanations.

Artificial intelligence (AI): This involves the use of computer to produce simulations of intelligent behaviours in robots to perform tasks usually performed by intelligent humans.

Benefits of Technology in Nigerian Schools

Educational technology combines different techniques to increase the effectiveness of teaching and learning in our various institutions. This is because it facilitates human learning through systematic identification, development, organization and utilization of a full range of learning resources and through the management of the available learning resources. Educational technology offers a wider choice of materials that can be accessed easily. This help learners to develop right kind of both skills and knowledge so that they can become good professions in their chosen field (Alexander, 2021).

It helps improve learner's communication skills and performance in school and workplace settings. It provides a fun and engaged learner learning settings experience for students.

It allows the learners to access the internet from anywhere at any time provided there is internet connection.

It helps learners' to learn new skills and acquire new knowledge.

It allows students to improve themselves both mentally and physically.

It helps learners and teacher to stay up to date with new technological advancements. This will likely enable job seekers to also easily find job in various fields.

Considering the benefits of integrating technology power in enhancing teaching and learning. Melio (2023) enumerated the following benefits of educational technology to include: students' ability to study at convenient time and from anywhere. For example, a person who is working can decide to take course online and not worry about time to attend classes. They just have to figure out how to balance work with school/study.

- Business people and specialist can get their desired certificates online.

- Use of technology in education enhances competencies beyond knowledge and skills. It results in improved understanding of concepts that are complex and will lead to connecting ideas, processes and learning strategies in students and even teachers regarding problem solving.
- Integrating of technology in education and classroom makes learning enjoyable and interesting.
- It also makes teaching easy and more immediate by bridging the gap between the world inside and world outside the classroom by means of experiences it provides.
- Technology helps you to track students' progress. One will no longer limited to a plan-old diary and notes about every students. Today, one can rely on platform and tools that enable one to keep track of individual achievements of one's students using "my-student-progress and the teacher cloud progress tracker (Ferrell, 2017). The 21st century world is a dynamic one, one that is ever changing and surrounded by information. It is therefore important that the type of education given to students should match the dynamic nature of the world. Technology in teaching has many benefits especially to students in secondary schools. The following are some of the benefits of technology in education.

Collaboration of Knowledge:

The employment of technology in the classroom is important as it allows students share knowledge among themselves anywhere. The use of technology in education allows knowledge mobility, this means that knowledge can be gotten, shared and used anywhere within the classroom and outside the classroom. This collaborative learning can be between teachers and students or within students.

Student Centered:

Using technology in the training as well as learning procedure makes teaching transcends beyond the traditional notion of the lecturer being the sole custodian of knowledge. With the use of technological gadgets like the internet, students can access any information they need and also learn at their own pace. Ajayi (2008) posits that training as well as learning has evolved passed the lecturer positioning himself in front of a collection of pupils as well as

circulating information to them without the pupil's adequate participation. This harnesses the point that technology in education makes teaching and learning less teacher centered and more student centered.

Convenience:

It makes educational activities easy and simple. With this blended method of teaching, students do not necessarily need to carry heavy backpacks, they can easily read and store information in their laptops, do exercise and send to their teachers at any time. Also, teachers do not need to carry scripts around as students works can be marked with the aid of technological devices. Technology in education is convenient for the trainers and the pupils.

Wider range of information:

The internet houses a lot of information, with thus, students can get more information about a subject area beyond the one they get from their textbooks. Through sites Like the Research Gate, Google scholar, Google and others, students has a wider range of access to informative information about different subjects.

Intensifies Teaching:

ICT gives room for students to learn intensively and thoroughly. Through audiovisual materials, students have a more concrete idea about the concepts they being taught. For instance if students are taught about how the intestines work and they get to only see a picture of the intestine, they nay get an abstract view of how the intestines really are, but with the help of the YouTube, students can see and even watch how the intestines functions, this has helped in intensifying the lesson the teacher has taught, with this students will not forget this concept easily, they will also be no need of memorizing because what they have seen will stick better.

Updated knowledge:

With the employment of technology in schooling, students are exposed to recent and updated knowledge about certain subjects instead of the old information in most textbooks. Studies to ascertain the academic potentials and benefits of mobile application, have shown that apart

from its benefits as a learning tool, learners vocabulary improved, their understanding of content/concepts improved, student/learners were more motivated to do well and prepared for class than their counterparts who did not use them (Wylie, 2016).

Challenges

Replacing the traditional method of teaching with modern technology has a lot of benefits in the educational system notwithstanding, there are still setbacks which includes:

- (1) Inadequate training: It is observed that these new techniques of teaching-learning has shortage of personnel and special training is needed for the existing ones so as to ensure effective integration of classroom technology. This training will enable the teachers to use software programmes to stimulate students to improve upon the under developed skills in a variety of content areas.
- (2) The use of technology in the classroom is capital intensive and only few schools can afford the equipment.
- (3) It is time consuming: Much time is needed for the implementation of technology in the classroom.
- (4) The quality of computer or digital cameras for classrooms are grossly inadequate.
- (5) Malfunctions of computer: Reacting to the malfunctioning of computer Osasebor and Okunsebor (2009) said that one of the major disadvantages of the application of computer in education in Nigeria is due to system malfunction which can be experienced in the computer itself. They added that computer in education depends largely on electricity and without it, it cannot function. Irregular supply of power has been a great problem to the use of computer in the classroom.
- (6) Absence of electricity in rural areas hinders the use of computer technology in the classroom in such locations.

Conclusion

The world today is powered by technology in virtually all areas of life and sectors of the economy. Education that is provided in any nation is to empower the citizens to fit successfully into their society. The 21st century world is ruled by information. Only individuals with the ability and skills to utilize modern digital tools to access and generate information and knowledge can and will perform in the global work space and platform. The technologies of today have completely changed the platform for learning. Students now learn from different sources. Teachers need to key into the modern learning modes by utilizing the tools offered by the digital revolution to prepare learners who are globally empowered. The idea of a fixed classroom where students learn only in the presence of their teachers and from what the teacher provides for them has gone long before now. Learners can now learn with the teachers directing even when they are separated by time and distance. This type of learning, apart from its efficacy in promoting self-paced learning, motivates learners to engage in research and dissemination of knowledge as fast as possible which are connected to networking and collaboration. To remain relevant therefore, teachers and students should keep abreast with the learning technologies of the time through re-engineering and innovating in system structure, perceptual change, instructional, administrative and assessment practices that are compliant with the 21st Century literacy skills.

Recommendations

The following recommendations have been put forward in this paper:

- (1) The need for adequate training of teachers and students (or learners) have become imperative in the 21st Century.
- (2) Appropriate machinery should be put in place to ensure that computers and its accessories are provided to schools via loan or subsidized rates for those who can pay at once. Checks should also be put in place to ensure they are not sold when in need of cash by those given.
- (3) Issue of allocation of more time to school programmes and activities be looked into. This is in fact a serious matter aimed at ensuring all that needed to be learnt is learn.

(4) Adequate supply and maintenance of computers in schools be looked into. This can be done periodically and avoid if necessary that such is not a conduit pipe to amass wealth by those at the helms of affairs.

(5) Alternative power supply to schools be massively invested on. This is especially as public electricity supply in the Country can no longer be relied upon.

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**EFFECT OF ENTERPRENUERIAL ATTRIBUTES AND START UPS
SUSTAINABILITY AMONG ENTREPRENEURSHIP GRADUATING STUDENTS
OF JOSEPH SARWUAN TARKA UNIVERSITY MAKURDI, BENUE STATE -
NIGERIA.**

BY

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ABSTRACT

The main objective of the study is to determine the effect of Entrepreneurial attributes and start-ups sustainability among entrepreneurship graduating students of Joseph Sarwuan Tarka University Makurdi. Specific objectives are to examine the effect of innovativeness on start-ups sustainability, to analyse the effect of self-efficacy on start-ups sustainability and to access the effect of locus of control on start-ups sustainability. The research design used for the study was descriptive survey design and sampling techniques was census methods to study the entire population of 106 were drawn from entrepreneurship graduating students of Joseph Sarwuan Tarka University Makurdi. Multiple regression analysis was used. The study concluded that innovativeness, self-efficacy and locus control has significant effect on start-ups sustainability. Based on the findings of the study, entrepreneurs should engage in capacity building programmes for starters on entrepreneurial skills, that will improve start-ups sustainability, skills development and enhances their creativity and risk-taking propensity towards starting, sustaining and managing businesses.

Key words: Entrepreneurial Attribute, Innovativeness, Self-efficacy, Locus of Control and Sustainability

INTRODUCTION

At the international front, the globalization and reforms like liberalization of trade, commercialization and privatization have open up new vista of opportunities for the small and medium scaled enterprises and entrepreneurs. The liberalization of trade through world trade agreement has opened up opportunities for the small and medium scale enterprises to access international markets.

The Nigerian government has made various programs to promote entrepreneurship as a career among the citizenry, specifically the youths and women. In addition to government efforts in the past, there is a renewed support for small scale enterprises. In 2005, Small and Medium Enterprises Development Agency of Nigeria (SMEDAN) was commissioned. The Agency has already completed a nation-wide survey on small and medium scale enterprises as basis for articulating ideas for micro, small and medium enterprises policy thrust. As the government at all levels are contributing not leaving the organized private sector in the effort of entrepreneurship program (Fatai, 2011).

In our universities, entrepreneurship have been demonstrated as a critical factor in providing not only knowledge, but skills, training and best learning models for the university students, (Oyugi, 2014). In recent times, entrepreneurship program is being taught in institutions which has raised a level of inspiration and intention among students. It has been found out that people are born with entrepreneurial traits but those traits must be developed by acquiring skills and expanding once knowledge. The university plays a major role in the area of developing and training students in the entrepreneurial career path. Zhang *et al* (2014), stated that “the teaching environment in the universities is most influential for the University students in their perceptions for entrepreneurial career development and they are most likely to venture into their own businesses. There must be a justification for the constantly growing number of universities offering entrepreneurship education programs (Lange *et al.*, 2011). These helps students to increase in their attributes, knowledge and capabilities to set up a business venture. With entrepreneurship education in place, graduates have the ability to acquire some entrepreneurial traits which can influence the graduate’s entrepreneurship behavior (Ediagbonya, 2013).

It’s summited above that entrepreneurial attribute can be acquired and one can obtain through well-designed entrepreneurship courses and training. Acquisition of entrepreneurial skills through entrepreneurship programs ignite the drive which lead to Start ups.

Statement of the Problem: Entrepreneurial attributes should be encouraged among university studies, because of the critical path it plays in providing not only knowledge, but skills, training and best learning models for the students, (Oyugi, 2014). Despite, academic

program designed to educate students on entrepreneurship, students have challenges on start ups development and is still an issue of concern among the student of Joseph Sarwuan Tarkaa University Makurdi. However, several studies have been carried out in line of the study, some of the studies that have been carried out in different area, locations and dimensions.

Objectives of the study: The main objective of the study is to determine the effect of entrepreneurial attributes on start ups among entrepreneurship graduating students of Joseph Sarwuan Tarka University Makurdi. The specific objectives are to examine the effect of innovativeness on start ups, to analyse the effect of self-efficacy on start ups and to assess the effect of locus of control on start ups.

Research Hypothesis: The following hypotheses are based on the problems and objectives of this research work: Innovativeness does not significantly enhance start ups, self-efficacy does not significantly affect start ups, and locus of control has no significant effect on start ups among entrepreneurship graduating student of Joseph Sarwuan Tarka University Makurdi (JOSTUM) Benue State.

Scope of the Study: Study is limited to entrepreneurial attributes on start ups among graduating students of Joseph Sarwuan Tarka University Makurdi (JOSTUM) Benue State. To this end, the content coverage of the study is limited to innovativeness, self-efficacy and locus of control and its effect on start ups and geographical scope is limited to the department of Management Science of

Joseph Sarwuan Tarka University Makurdi (JOSTUM), the study covered a period less than a year which tries to find out the effect of entrepreneurial attributes on Start ups among Students.

LITERATURE REVIEWED

This section presents a reviewed of literature that is relevant to the study. This section is presented under the following sub-heading: conceptual framework; theoretical framework and review of related empirical studies.

Theoretical Framework

Two theories are used for the study because of their relevance to the study. They are; Innovation and Need for Achievement theories.

Innovation Theory

This theory was propounded by Schumpeter (1953). According to Schumpeter, entrepreneur is basically an innovator and innovator is one who introduces new combinations.

In practice, new combination theory covers five cases which are given below:

(i) The introduction of a new good which consumers, are not yet familiar—or of a new quality of a good.(ii) The introduction of a new method of production, that one not yet tested by experience in the branch of manufacture concerned, which need by no means be founded upon a discovery scientifically new and can also exist in a new way of handling a commodity commercially.(iii) The opening of a new market i.e. a market into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market has existed before.(iv) The conquest of a new source of supply of raw materials or half manufactured goods, irrespective of whether this source already exists or whether it has first to be created.(v) The carrying out of the new organisation of any industry like the creation of a monopoly position (for example, through trustification) or the breaking up of a monopoly position.

Relevance of the Theory to the Study

Innovation is the core through which entrepreneurship activities are hitched on, it therefore means that innovation is an integral component of entrepreneur; it is what distinguishes a business from those that are not entrepreneurial. When entrepreneurs are faced with difficult challenge, the ability to introduce newness in their methods of production, product and market will enable them succeed because innovation does not only heighten the competition; it increases profits for the entrepreneur and creates job.

Need for Achievement Theory

This theory was developed by McClelland (1953). McClelland concerned himself with economic growth and the factors that influence it. In this context, he tries to find the internal factors i.e. “human values and motives that lead man to exploit opportunities, to take advantage of favourable trade conditions.” That is why he gives importance to the innovative

characteristics of entrepreneurial role. The entrepreneur is concerned with need for achievement (n-ach), need for power (n-pow) and need for affiliation or belonging (n-aff). The n-achievement is called as “a desire to do well, not so much for the sake of social recognition or prestige, but for the sake of an inner feeling of personal accomplishment.”

It is this motive of n-achievement that guides the actions of entrepreneur. People with high n-achievement behave in an entrepreneurial way. So it is better to develop n-achievement among individuals to ensure high scale of economic development. In practice, n-achievement motive is inculcated through child rearing practices, which stress standards of excellence, material warmth, self-reliance, training and low father dominance.

McClelland identified two characteristics of entrepreneurship. First doing things in a new and better way. Secondly, decision making under uncertainty. This motive is called as the tendency to strive for success in situations involving an evaluation of one's performance in relation to some standard of excellence. People having high need for achievement are more likely to succeed as entrepreneurs.

According to McClelland, individuals with high need achievement will not be motivated by monetary incentives but that monetary rewards will constitute a symbol of achievement for them. Similarly, they are also not interested much for social recognition or prestige but their ultimate goal is personal accomplishment. That is why McClelland suggests that in order to raise the level of achievement motivation, parents should set high standards for their children.

Conceptual Framework

Concept of Entrepreneurial Attributes

Entrepreneurial attributes have grown the level of importance placed on the development and sustainability of the economy (Fatai, 2011). Two clusters of thought on the meaning of entrepreneurship. One group focused on the attributes of entrepreneur (e.g. innovation, growth, uniqueness) while a second group focused on the outcomes of entrepreneur (e.g. the creation of value). The concept of applied entrepreneurship argues that an entrepreneurial firm focuses on innovation, is open to risk and proactive in relation to its competitors.

Dimensions of Entrepreneurial Attributes

Below are the dimensions of Entrepreneurial Attributes

i. Innovativeness

An entrepreneur adopting innovative style relies on knowledge that is possessed from both internal and external environment (Mahmood and Rufine, 2015). It is such that it embraces creativity in technology adoption and internal process (Baker and Sinkula, 2019). Wang (2008) describe innovativeness as fostering a spirit of creativity, supporting research and development and experimentation, introducing new products/services as well as processes. Several studies suggested that innovative firms create extraordinary performance, gain economic growth and apply creativity in business environment (Laukkanen, *et. al*, 2013). They ability of entrepreneurs to be creative, and unique in their products, modes of operation and markets will enable them bounce back in the event of failure and enhance their performance. The contemporary understanding of entrepreneurial behavior requires a more robust understanding of not only innovative behavior but also how entrepreneurs are often perceived to cope with difficulties and failures.

ii. Self-efficacy

Self-efficacy is thus the foundation for personal achievements, personal well-being and human motivation. Bandura (1977) depicts the role of self-efficacy beliefs in human functioning as “people motivation, affective states and actions that focuses more on what they believe than on what is objectively true. Self-efficacy has an impact on an individual’s emotional reaction and thought patterns. Bandura (1986) describe self-efficacy as a function of self-belief through which individuals are able to accomplish a given task. Thus it is believed that high perseverance that is associated with self-efficacy will definitely lead to increase performance and productivity. Self-efficacy has proven to be a good measure which can be used to predict behavioral outcomes when compared to any other motivation construct in psychology and education.

Internal locus of control

Locus of control simply refers to one's believe in his or her abilities to control life events (Stauser, 2002). The utmost belief of locus of control is related to what reinforcement have occurred throughout an individual life, this could be in terms of result, prices their success or failure. These attributions refer not only to chance, fate or power, but more importantly as a result of his or her attitude (Basim and Ssasen, 2006). Locus of control could be internal or external: when one's control on his/her own life is dependent on chance, factors such as chance, fate. Influential people are all regarded as external control. Internal control can be described as maintaining the individual control over one's life or his/her own (Rotter, 1966). Individuals who have internal locus of control believe they have a great role on affecting the event which influence their live and responsibility in shaping the events surrounding. They further assess their selves as possessing the required power for the attitude they want to display by having the positive ego concepts and they strongly believe they can direct their lives whatever way they desire (Gulveren, 2008).

Concept of Start-ups

According to (Agbo, 2000) defines business start-up as the activity of an entrepreneur to exploit new ventures opportunities, bear-risk and put organize resources together to gain profit. Business start-ups are triggers by the prevailing opportunities within the business environment which is normally to gain profit and the expense of other businesses. A startup is generally defined as a new business that entrepreneurs initiate by combining businessideas and resources.

Ries (2003) explained that a startup is an organization that has been launched to create new products or services in extreme uncertainty. He argued that if they are creating new products or services in extreme uncertainty, then all of them, such as the new business units of governments, large companies, non-profit organizations, and business ventures, may fall under the startup category. Unlike small businesses that are classified according to the size of their work, the above definition implies that new companies with a new idea based on the knowledge industry can be called a venture, startup, or entrepreneurship. Smith and Miner (2001) classified startups as craftsmen and technical entrepreneurs who want to materialize

their own functions and technologies and as opportunistic entrepreneurs whose initiatives are based on market opportunities according to their motivation.

Measurement of start-ups

i. Small business startups

Small businesses are the most widespread type of startups and make up the major part of any country's economy. On the one hand, they do not require too much capital and investment and therefore are easier to start up; yet on the other hand, they do not usually bring a lot of profit and serve their owners to cater for their families. They are not designed for scale, go largely unnoticed by investors and their employees are either the family relatives or friends, but they create local jobs and by sheer numbers they form the core of "entrepreneurship". The most common small businesses are service-oriented: drycleaners, gas stations and mom and pop stores. A good salary for the owners and a profit are the benchmarks entrepreneurs set for small business success. Since small businesses usually have a few employees and a relatively low profit, they are rarely designed to overtake an industry or become \$100 million businesses. In the US, [the official definition of a small business](#) is an independent business with less than 500 employees. Small businesses make up the majority of startups in the United States. In 2009, there were 27.5 million small businesses comprising 99.9% of all US companies. According to the US Small Business Administration, almost half of the US workforce is employed at small businesses.

ii. Scalable startups

When we imagine startups that bring billion profits and hit all headlines overnight, we think of scalable startups: Google, Twitter and Facebook are examples. Such startups rely on their owners' belief that someday they will thrive and develop into another giant. The owners are usually visionaries that hope to change the world — and attract rich investors. The concepts with which such startups are formed are powerful and the startups themselves tend to group together in innovation clusters. A **scalable startup** is one that starts with an innovative idea and creates a business model designed to turn the company into a profitable, high growth enterprise. Scalable startups succeed by either entering a large market and taking market

share away from other companies or creating a market and growing it rapidly. This type of startup is the most common among traditional technology entrepreneurs. Unlike small businesses which are everywhere, scalable startups tend to be concentrated in the world's technology hubs and only constitute a small percentage of entrepreneurial ventures.

Scalable startup entrepreneurs start their venture with the belief that their vision will change the world and make them lots of money. A scalable startup starts with the search for a repeatable and scalable business model. Outside venture capital in the tens of millions is usually required so that a startup can meet market demand and scale. Startup entrepreneurs need to sell investors on their vision in order to hire employees and acquire their first customers.

iii. Large company startups

Large companies despite their seeming stability and large revenues are constantly threatened by inventive and innovative competition from other large organizations. Together with changes in customer tastes, new technologies and legislation such competition can create pressure for more disruptive innovation. This means that companies have to invest into improving efficiency and also fresh skills and structures, requiring development of entirely new products that might be sold to new customers in new markets. **Large Company Entrepreneurship** **Internal startups** are new business divisions created within large or well-established companies and operated at arm's length. Since large companies have finite life cycles, they need new products in order to grow. Most companies grow through variants on their core product (an approach referred to as sustaining innovation). Internal startups are formed through disruptive innovation, where new products are created for new markets, and therefore, new customers. As you can imagine, the size and culture of large companies make disruptive innovation difficult, but there have been some successful internal startups. Target Corporation began as an internal startup within the Dayton Hudson department store chain. The P2P and communication application threedegrees was developed by an internal startup within Microsoft.

iv. Buyable startups

Buyable startups are companies that were started to be sold to a larger company in the niche. Such companies are usually started with little capital, developed and quickly sold off to other companies when their value peaks. As a result, their owners earn several thousand to millions of dollars and are ready to use the revenue to redo business and earn more. Such startups usually involve web and application development with the aim to be bought by internet conglomerates. The goal of a **"buyable" startup** is to create a product (usually a mobile or web app) and then be sold to a larger company. Buyable startup entrepreneurs are usually happy to sell their company for \$5 million to \$50 million. "Buyable" startups are usually funded through the founders' credit cards along with small amounts of risk capital. Larger companies usually purchase buyable startups in order to acquire the talent as well as the business itself.

v. Lifestyle startups

More than any other type of startups, lifestyle ones are about passion as profession. Their owners usually try to generate profit by living the life they love. The most common examples of such businesses are giving surfing lessons or yoga classes by enthusiasts, starting a photo studio or a gym to serve other people with the same interest and make money.

vi. Social startups

This type of startups involves usually some form of charitable foundation. Their goal is to make the world a better place, but, unlike scalable startups, their owners are not driven by the wish of wealth or power. In principle, these startups can be organized as a for-profit, non-profit or hybrid and they usually depend on donations from the likeminded people. **Social entrepreneur** is used to build innovative non-profits worldwide. Unlike other types of entrepreneurship, social entrepreneurship is about finding solutions instead of making a profit.

Reviewed of Related Empirical Studies

Oyeniya and Adeniji (2010) carried out a study on entrepreneur psychological traits and growth of business start-up implications for Nigeria non-oil small and medium enterprises exporting companies. The objective of the study was to investigate the impact of locus of control and the need for achievement on performance business start-up size exporting firms in a developing country. The study made use of survey method while the population consisted of 123 firms. Descriptive and inferential statistics were used to test hypotheses. Results of the findings indicated that psychological traits tested (need for achievement, locus of control, self-efficacy) are related among them and positively related to performance of the studied firms. No doubt the study by Oyeniya and Adeniji is closely related to the current study, the study failed to give a precise methodology it uses to arrive at the selection of the sample and its method for analysis seems not to be adequate for the study.

A study conducted by Cherian & Jacob (2013) on the impact self-efficacy on the motivation and growth of business start-up in Abu Dhabi. The aim of the study was to perform a Meta-analysis which analyses the individuals' findings which pertains to the relationship between self-efficacy, employee motivation and work related performance of business start-up in Abu Dhabi. The researcher reviewed the literature from 2000-2012 to identify relevant studies. Data was obtained using standardized data extraction forms. The result of the study indicated that self-efficacy plays a mediating role in the relationship between managers rated effectiveness and employee engagement. The study by Cherian and Jacob like the present study depended on the review of literature in drawing conclusions which is basically relied on findings from previous studies which might not reflect the real situation on ground.

Olughor (2015) investigated the effect of innovation on the performance of SMEs organization in Nigeria. The objective of the study was to determine how innovation affects business growth in small and medium sized enterprises in an upcoming market like Nigeria. Data was collected from 200 respondents of six SMEs based in Nigeria. Innovation was measured using the OECD oslo scale (2005). The study demonstrated that there is a high correlation among factors used to measure innovation. The study by Olughor no doubt is relevant to the present study. However, the sample size is inadequate for the study when

compared to the scope which is Nigeria also the basis for selection of the SMEs were not clearly stated.

A study was conducted by Bouchard-Bouffard (2016) on the influence of self-efficacy on performance of business start-up in a cognitive task. The objective of the study was to investigate the influence of self-efficacy judgment on cognitive performance of business start-up when subjects had equivalent knowledge and experience in the performance domain. The sample size consisted of 64 Canadian students who volunteered to participate. A Pearson product moment correlation was used to analyze data. Findings revealed that the perception of self-efficacy is vital construct for comprehending Performance particularly in academic task requiring sustained self-monitoring. The study by Bouchard- Bouffard has close nexus with the current study, however the point of deviation is that the study was carried out on students and to determine the influence of self-efficacy on performance in a cognitive task while the current study is concerned about self-efficacy as a characteristic trait that will assist the entrepreneur in overcoming shocks. The sample size for the study is also inadequate to draw overwhelming conclusion

Similarly, Yazeed (2017) conducted a study on the effect of entrepreneurial characteristics on the profitability of business start-up in Kaduna State. The objective of the study was to investigate the effect of self-efficacy, risk taking and locus of control on the profitability of business start-up in Kaduna State. A cross sectional survey research design was employed in the study. The population of the study consisted of 201 business start-ups out of which questionnaires were retrieved from only 174 MSMEs. Stratified and simply random sampling techniques were used in selecting samples and the unit of analysis was owner manager representing each MEMEs. Inferential statistics was used to analyze data collected from the field with the aid of SPSS while multiple regressions were used to test hypotheses. Findings revealed that self-efficacy, risk taking and locus of control all have significant positive effect on the profitability of MSMES in Kaduna State. The study population and method of analysis is commendable for the study, Yazeed study no doubt is related to the present study, the study variables are the same; the point of departure is the inclusion of risk taking as the present study made use of innovativeness.

METHODOLOGY

Research Design: The research adopted descriptive survey design, which talks about the relationship between the dependent variable and independent variable.

Population of the Study: The study population is made up of 106 graduating students of Joseph Sarwuan Tarka University Makurdi, (JOSTUM) Benue State.

Sample Size and Sampling Technique: Data was being collected with the use of a structured questionnaire which was administered to the 106 graduating students of Entrepreneurship of Joseph Sarwuan Tarka University Makurdi, (JOSTUM) Benue State. The questionnaire was distributed to the students of Joseph Sarwuan Tarka University Makurdi (JOSTUM) Benue State.

A 5-Point Likert Scale was used from 1 to 5 where by (1 = Strongly Agree, 2 = Agree, 3 = Undecided, 4 = Disagree and 5 = Strongly Disagree) was used.

Validity and Reliability of Instrument: Validity is the extent to which an instrument measures what it is supposed to measure, which is correlating the score with similar instrument.

In establishing the reliability, the response to each of the statements was on a 5 Point Likert scale. A pilot study was carried out on the sample size representing $(106 \text{ of } 1/3) = 53$ who were students of University of Mkar Gboko, Benue State and the test and re-test results showed 46 and 50 respectively which indicate the reliability of the instrument.

Model Specification: The variable specification shows that Entrepreneurial Attribute is the independent variable proxied by innovativeness, self-efficacy and locus of control while Start ups is the dependent variable measured by student's focus. Thus the study adopted the correlational study based on the following functional relationship: $EA = f \{INN, SE \text{ and } LC\}$.

Thus the model is as follows: $EA = \beta_0 + \beta_1 INN + \beta_2 SE + \beta_3 LC + \mu$, where: EA = Entrepreneurial Attribute, INN = Innovativeness, SE = Self-efficacy, LC = Locus Control and μ = Error Term.

A prior expectation: $\beta_1 > 0, \beta_2 > 0, \beta_3 > 0, \beta_4 > 0$. This mean that entrepreneurial attribute dimension under study, namely innovativeness, self-efficacy and locus control are expected to positively influence start ups of new businesses.

Data Analysis Technique: Multiple regressions were used for data analysis.

RESULTS AND DISCUSSION

The regression analysis result is presented in model summary, analysis of variance and regression coefficients.

i. **Model Summary:** The result from Table 1 below shows that coefficient of determination (R square) explains the variation in the dependent variable due to changes in the independent variable. The R square value of 0.821 is an indication that there was variation of 82.1 % in start ups due to changes in entrepreneurial attribute. Also, the value of R (0.906) from the Table 1 below shows the relationship between the study variables which implies that there was a strong positive relationship between the study variables.

Table 1: Model Summary

R	R-Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
.906 ^a	.821	.769	.29915	2.314

Source: SPSS Output, 2021

Predictors (Constant), Innovativeness, self-efficacy, Locus of Control

Dependent Variable: Start ups.

ii. **Analysis of Variance (ANOVA):** The result from the ANOVA statistics in Table 2 below indicates that the processed data, which is the population parameters,

had a significance level of 0.000 which shows that the data is ideal for making a conclusion on the population's parameter as the value of significance (p-value) is less than 5%. This implies that innovativeness, self-efficacy and locus of control significantly influence start ups. The significance value was less than 0.05 which indicates that the model was statistically significant ($F = 33.256$; $P = .000$).

Table 2: Analysis of Variance (ANOVA)

	Sum of Squares	df	Mean Square	F	Sig.
Regression	11.905	3	2.976	33.256	.000 ^b
Residual	2.595	178	.089		
Total	14.500	181			

Source: SPSS output, 2021

Dependent Variable: Start ups

Predictors (Constant), Innovativeness, Self-Efficacy, Locus of Control.

iii. Regression Coefficients: From the data in the Table 3 below the established regression equation is presented thus: $Y = 0.957 + 0.924 (\text{Innovativeness}) + 0.952 (\text{Self-efficacy}) + 0.907 (\text{Locus of Control})$.

The regression equation above revealed that innovativeness, self-efficacy and locus of control to a constant zero, start ups would be 0.957, a unit increase in innovativeness would affect start ups by a factor of 92.4 %, a unit increase in self-efficacy affect start ups by 95.2 % and a unit increase in locus of control would affect start ups by 90.7 %. The study also found that the p-values innovativeness, self-efficacy and locus of control respectively were less than 0.05 which is an indication that the effect of

innovativeness, self-efficacy and locus of control was enough to positively affect start ups of new businesses

Table 3: Regression Coefficients

	Unstandardized		Standardized		
	Coefficients		Co-efficient		
	B	Std. Error	Beta	t	Sig.
(Constant)	.857	.418		.856	.000
Innovativeness	.924	.111	.025	3.211	.024
Self-efficacy	.952	.086	.407	3.370	.014
Locus of control	.907	.119	.898	7.605	.000

Source: SPSS output, 2021

a. Dependent Variable: Start ups

Test of Hypotheses

Hypothesis One: Innovativeness does not have significant effect on Start ups among Entrepreneurship Gradating Students of Joseph Sarwuan Tarka University Makurdi (JOSTUM). To test this hypothesis, the strength of the effect of innovativeness on start ups was measured by the calculated p-value = 0.025 at a significance level (α) of 0.05. Since the computed p-value is less than the significance level (α) of 0.05 (p -

value $0.024 < \alpha 0.05$), the null hypothesis was rejected. It is therefore concluded that there is significant effect of innovativeness on start ups of new businesses.

Hypothesis two: There is no significant effect of self- efficacy on Start ups among Entrepreneurship Gradating Students of Joseph Sarwuan Tarka University Makurdi (JOSTUM). The strength of the effect of self-efficacy on start ups was measured by the calculated $p\text{-value} = 0.407$ at a significance level (α) of 0.05. Since the computed $p\text{-value}$ is less than the significance level (α) of 0.05 ($p\text{-value } 0.407 < \alpha 0.05$), the null hypothesis was rejected. It is therefore concluded that there is significant positive effect of self - efficacy on start ups of new businesses.

Hypothesis three: Locus of control does not significantly effect on Start ups among Entrepreneurship Gradating Students of Joseph Sarwuan Tarka University Makurdi (JOSTUM). The strength of the effect of locus of control on start was measured by the calculated $p\text{-value} = 0.898$ at a significance level (α) of 0.05. Since the computed $p\text{-value}$ is less than the significance level (α) of 0.05 ($p\text{-value } 0.898 < \alpha 0.05$), the null hypothesis was rejected. It is therefore concluded that locus of control has significant effect on start ups of new businesses.

Discussion of Findings: The study found that: innovativeness has a significant effect on Start ups among Entrepreneurship Gradating Students of Joseph Sarwuan Tarka University Makurdi (JOSTUM). (the calculated $p\text{-value} = 0.025$ at a significance level (α) of 0.05). There is a significant effect of self-efficacy on Start ups among Entrepreneurship Gradating Students of Joseph Sarwuan Tarka University Makurdi (JOSTUM). (the calculated $p\text{-value} = 0.407$ at a significance level (α) of 0.05) and locus of =control has a significantly effect on Start ups among Entrepreneurship Gradating Students of Joseph Sarwuan Tarka University Makurdi (JOSTUM). The findings are consistent with the works of other authors in the field of entrepreneurship.

Conclusion: This study concludes that entrepreneurial attribute has statistical positive significance effect on start ups of new businesses. And all the sub-variables (innovativeness,

self –efficacy and locus of control) have positive effect on Start ups among Entrepreneurship Gradating Students of Joseph Sarwuan Tarka University Makurdi (JOSTUM).

Recommendations

The study recommended that:

- i. The entrepreneurship graduating students should think towards innovativeness of as it has low contribution (25.0%) to her performance.
- ii. There should be expression of self- efficacy because it has contribution (40.7%) more than innovativeness and.
- iii. There should be focused on locus of control as it contribution (89.9%) is the highest on start ups among the dimensions of entrepreneurial attribute.

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EFFECTS OF NPK (15:15:15) FERTILIZER AND COW-DUNG ON GROWTH AND YIELD OF WATERMELON (*Citrullus lanatus*) PLANT IN BAUCHI LOCAL GOVERNMENT AREA OF BAUCHI STATE, NIGERIA.

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ABSTRACT

*This study aimed to assess and determine the effects of Cow-dung, N.P.K (15:15:15) fertilizer, both individually and in combination on the growth and yield of watermelon plants in Bauchi Local Government Area (L.G.A) of Bauchi State, Nigeria. The specific objectives include evaluating the response of watermelon plants to Cow-dung, N.P.K (15:15:15) fertilizer, and their combination, as well as comparing their impacts on growth and yield parameters. The study also sought to identify the most effective fertilizer option for watermelon farmers in the region. Watermelon (*Citrullus lanatus*) is a widely cultivated vine plant known for its spherical fruits used as culinary vegetables. This research focused on the response of watermelon plants to different fertilization methods and their influence on growth and yield outcomes. The study was conducted inside plant nursery of the department of Forestry Technology, Federal Polytechnic, Bauchi. The findings indicated that the combinations of mineral (N.P.K 15:15:15) and organic (Cow-dung) fertilizers produced the most significant positive impact on both vegetative growth and fruit yield of watermelon plants. This suggested that the synergistic effect of combining these two types of fertilizers leads to enhanced growth and development of the watermelon plants and results in higher fruit yields. This study provided valuable insight into the cultivation of watermelon plants in the specific agricultural context of Bauchi L.G.A, Bauchi State, Nigeria. These results underscored the potential benefits of employing a combination of mineral and organic fertilizers for optimizing watermelon crop production. These findings can guide watermelon in selecting the most effective fertilization strategy to enhance their agricultural practices and overall yields.*

Keywords: *Effects, NPK (15:15:15) Fertilizer, Cow-dung, Watermelon (*Citrullus lanatus*) Plant, Growth, Yield.*

1.1 INTRODUCTION

Watermelon is one of the most important fruit crops in the world. Human have known watermelon (*Citrullus lanatus*) for centuries and noticed the nutritional importance of its fruits. Watermelon is a herbaceous creeping plant belonging to the botanical family Cucurbitaceae or gourd family which thrive in the tropical region and has been cultivated for thousands of years in the Middle East and South-South Nigeria. Watermelon is very rich in

source of nutrients such as photochemical and lycopene and often used as an appetizer or healthy snack, depending on the way it is prepared. Watermelon is considered as a summer crop and it has good economic importance because it is highly marketed crop in the local markets and for export. Watermelon is among the most widely cultivated crops in the world and the acreage of watermelon increased in the past years. According to FAO 2014, Bauchi produces 1,559 tons and the cultivated area was 44 hectares. Watermelon not only tolerates hot weather but for best growth requires more heat than any other vegetables. Watermelon seeds germinate well and plants thrive at 25°C - 30°C. Fruits mature best at 30°C. Watermelon (*Citrullus lanatus*) plant is a herbaceous creeping plant which produces from 3 to 5 fruits weighing from 3 to 10 kilograms, some cultivars such as the “Florida Giant” may weigh up to 20 kilograms. In order to improve the yield of watermelon, the soil content of nutrients should be increased to increase the fertility which can be achieved by either using organic fertilizer such as cattle manure, or by using chemical fertilizers mainly Potassium and Nitrogen compounds. Scientists have been interested in studying organic materials especially for its benefits for the plant, soil and recently for the environment.

1.2 Significance of the Study

The findings of the study are significant to agricultural science teachers, agricultural science students, extension workers, future researchers, and watermelon farmers. Agricultural science teachers will benefit immensely from the findings of this study. The findings will update the body of knowledge centered on the subject matter with new facts. Agricultural science teachers will therefore find the result of this study useful as added and current information are acquired and this will help to enrich their knowledge in lesson delivery. Similarly, they can quote the findings of this study to support similar findings in other research endeavours.

Agricultural science students will benefit from the findings of this study as current and valuable contribution to their knowledge. This is especially so as the subject matter of this study relates to the curriculum content of Agricultural science courses, particularly plant science and agronomy. Agricultural extension workers will, through the findings of this study, understand more the nature of watermelon plants’ response of N.P.K (15:15:15) fertilizer and cow dung. This improved understanding will be a valuable input to their

continuous search for ways of assisting farmers. By exploiting this enhanced understanding, they can engage appropriate counsel in helping farmers improve the productivity of their watermelon plants.

Similarly, future researchers and scholars conducting studies on related subject matter will find the findings of this study very useful literature. Besides, the findings will form the basis of scholars' further research works. Curious watermelon farmers will also utilize the findings of this study, to improve their competences in watermelon production for increased productivity and make more profit.

a. Objectives of the study

The purpose of the study is to determine if any significant difference exists between N.P.K (15:15:15) fertilizer and cow dung manure in their effect on the growth and yield of watermelon plants grown on experimental plots on natural soil.

1.3.1 General objectives of the study

This study intends to examine the effects of cow dung (cow manure) organic fertilizers and one type of chemical fertilizer N.P.K (15:15:15) on the growth and yield of watermelon in Bauchi Local Government Area of Bauchi State.

1.3.2 Specific Objectives of the study

Specifically, the study seeks to;

1. Find out the effect of N.P.K (15:15:15) fertilizer on the vegetable growth and fruit yield of watermelon plants grown on experimental plots on natural soil in Bauchi Local Government Area of Bauchi State of Nigeria;
2. Find out the effect of cow dung manure on growth and yield of watermelon plants grown on experimental plots on natural soil in Bauchi Local Government Area of Bauchi State;
3. Compare the effect of N.P.K (15:15:15) fertilizer with the effect of cow dung on the growth and yield of watermelon plants grown on experimental plot on natural soil in Bauchi Local Government Area of Bauchi State of Nigeria.
4. Find out the effects of the combinations of N.P.K (15:15:15) fertilizer and cow dung manure on the growth and yield of watermelon plants grown on experimental plots on natural soil in Bauchi Local Government Area of Bauchi State, Nigeria.
5. To proffer the best fertilizer to watermelon farmers in Bauchi, Bauchi State of Nigeria.

1.4 Statement of Hypothesis

H₀: There is no significant difference between the growth and yields of watermelon plants grown with N.P.K (15:15:15) fertilizer and cow dung on experimental plots on Natural soil in Bauchi Local government Area of Bauchi State, at $P \leq 0.05$ level of significance.

H_a: There is significant difference between the growth and yields of watermelon plants grown with N.P.K (15:15:15) fertilizer and cow dung on experimental plots in Natural soil in Bauchi Local Government Area of Bauchi State, at $P \leq 0.05$ level of significance.

1.5 Operational definition of terms

Effect:

The action of both N.P.K (15:15:15) fertilizer and Cow dung on the growth and yield of watermelon.

Fertilizer:

The nutrient that is been added to the soil to increase fertility which could be organic or inorganic.

N.P.K (15:15:15) fertilizer

The type of inorganic chemical fertilizer that contains 15% Nitrogen, 15% Phosphorus and 15% Potassium.

Cow dung:

The organic manure gotten from cattle waste.

2.0 LITERATURE REVIEW

This chapter presents the review of related literature, and is organized under the following sub-headings:

2.1 Theoretical framework.

2.2 Origin, description and growth requirements of watermelon plants.

2.3 Agronomic practices of watermelon plant.

2.4 Agronomic benefits and effects of NPK 15:15:15 fertilizer on watermelon plants.

2.5 Agronomic benefits and effects of cow dung on watermelon plants.

2.6 Empirical studies on the effects of NPK 15:15:15 fertilizer and cow dung on the growth and yield of watermelon plants.

2.7 Summary of Literature Review.

2.1 Theoretical Framework of the Study

The fundamental reason for planting Watermelon plants by farmers in Bauchi Local Government Area of Bauchi State, is to satisfy some economic, social and cultural need. The improvement and expansion of Watermelon production in the area may find explanations in some theories which have been developed and applied in the fields of economics and management. One of these theories is the production theory. The production theory identifies the factors on which production depends and the reward which each factor receives for its role in production. One of the ideas of the production theory is that entrepreneurs organize the other factors of production for economic rewards. The organizing role of entrepreneur rests on three believes. These are:

1. That the factors of production are complimentary and make production possible when they combine their resources in the pursuit of economic rewards;
2. That the factors of production must combine and function together for the attainment of a common purpose in distinct production stages, of which input, transformation, output, and distribution are major stages (Etuk, 2011: 15).
3. The theory of production describes the laws of proportion; that is, the transformation of factor inputs into Products (Output/yield) at any particular time.

Furthermore, the theory recognizes that various techniques and methods of production (process/activities) exist by which the factors of production (Land, Labour, Capital and entrepreneur) may be combined for the production of one unit of output. It also makes the distinction between factors and inputs and recognizes that production requires inputs which are transformed into outputs, in the production process. Watermelon is a commodity whose production is in line with the ideas contained in the theory of production. Watermelon production has four factors. These are;

Entrepreneurs, which are the farm owners;

Labour which are the mental and physical efforts of the farm owners, including hired and non-hired labourers;

capital, which is the financial resources used to procure other resources as well as the simple and complex machines and capital items used on Watermelon farms;

Land, which is soil in its physical and chemical properties used for cultivating Watermelon plants.

Furthermore, corresponding with the ideas of the production theory, Watermelon may be produced using various production methods. In any particular method of production used, NPK (15:15:15) fertilizer and cow dung together combined, in controlled production processes, to result in growth and yields of Watermelon fruits. In essence, the physical and chemical properties of land, the mental and physical efforts of farm labour, and the work done by agricultural capital items, such as watering cans as well as farm machines and tools, are peculiar factors of watermelon production.

However, Watermelon is produced when farm owners (the entrepreneurs) organize these peculiar factors to provide the enabling environment for natural metabolic processes to transform seeds, NPK (15:15:15) fertilizer and/cow dung manure, water, and other inputs to watermelon fruits. With regards to this research, Fertilizer and manure are variable inputs of fundamental importance. They correspond with aspects of the production theory which recognize input as the starting point of production and as the most important determinant of the value of output, in the production process. According to the production theory, the efficiency of inputs is directly related to the efficiency of output. These aspects of the production theories are the fundamental principle guiding this study. Fertilizer (NPK 15:15:15) and organic manure (cow dung) are materials added to the soil to serve useful purposes which include improvement in soil nutrients, soil structure, soil water infiltration, soil microbial population and, ultimately, crop growth and yield. How well these materials individually serve these purposes defines their individual efficiencies and how well they serve these purposes when they are combined defines their collective efficiency. In watermelon production, the determination of the efficiencies of these materials, as

individuals or combined inputs, depends on the value or efficiency of output (watermelon yield) traceable to them.

2.2 Origin, Description and Growth Requirement of Watermelon

2.2.1 Origin of watermelon

Watermelon (*Citrullus lanatus*) is a flowering plant species of the Cucurbitaceae family and the name of its edible fruit. A scrambling and trailing vine-like plant, it is a highly cultivated fruit worldwide, with more than 1,000 varieties.

The Watermelon plant belongs to the family Cucurbitaceae. It has a botanical name called *Citrulluslanatus* (Wikipedia, 2018:1). The plant produces the Watermelon fruit which, for purely culinary purpose, is often included among vegetables (Clerk, 2010:1). It probably originated in the highlands of the west coast of South America but is grown all over the world. In Nigeria, Watermelon is grown all over the country in all seasons. Many varieties exist; among which are *Citrullus caffer Schrad*, *Citrullus citrullusSmall*, *Citrullus edulis Spach*, etc (Smith, 2017). Some varieties have erect stems while others have semi-climbing weaker stems, and need support for good yield (Acquach, 2010:23).

2.2.2 Description of watermelon

The Watermelon plant is an annual or a short-lived berennial, dicot, although it is always cultivated as an annual crop (Smith, 2014:18). After planting, it takes Watermelon between 50 to 95 days to fruit and ripen, depending on the cultivar (Peet, 2010:1). According to Clerk (2018), The Watermelon plant is a deep rooted crop and a heavy feeder. It does not have a single primary tap root, but has a branching tap and fibrous root structure. The roots grow to a depth of 120 - 150 cm or more. The crop is green in colour and covered by reddish hairs, some of which secrets a smelly reddish juice. The vine grows to a length of six feet in some varieties. The leaves are alternately arranged and pinnately compound. The fruit shape is most commonly spherical but pear-shaped. Oval types also exist. The fruit is a berry whose colour is greenish when unripe and reddish when ripe.

2.2.3 Requirements of watermelon

The Watermelon requires a number of physical and chemical conditions to produce optimally. It is tolerant to a wide range of soils. According to Benton (1998) "The Watermelon plant grows well under a range of soil properties from sandy to fine-textured clay. The soil must, however, be well drained, have a good structure and is well aerated and loose." Also the soil must have subsoil characteristics devoid of naturally occurring or ploughing-created hardpan (Shukla & Naik, 2013:364). The Watermelon plant grows well within a soil pH range of 5.5 to 6.8, with optimum range being 6.0 and 6.5 (Benton, 2018:425). In the opinion of Calkins (2010), "A range of pH 6.0 to 7.0 is compatible for growing Watermelon. This is exactly the range in which soil organisms do best." Considered moderately sensitive to salinity, the Watermelon plant can tolerate a salinity level of up to 2.5 dissolve salt/meter without significant yield loss (Athorn, and Rudich, 2010:180). The Watermelon plant has a high requirement for the elements K and Ca and the micronutrients Fe, Mn, and za; and has a medium requirement for the elements N, Mg, P, S and the micronutrient Cu (According to Yawalkar, Jakate and Srivastava (2015), "a Watermelon crop yielding about 38 mt/ha of fruit removes 104 kg N, 9.5 kg P and 116 kg K from the soil." Atherton and Rudich (2019) stated that "To produce 1 mt/ha of fresh fruit, Watermelon plants need to absorb, on average, 2.5 to 3 kg N, 0.2 to 0.3 kg P and 3 to 3.5 kg K." Hegde and Srinivas (2012) studied NPK uptake in Watermelon in soils with different levels of soil matric potential and applied N. They observed that nutrient uptake declined with increasing soil moisture stress, and increased with higher levels of N application. They reported that a crop yielding 60.8 mt/ha of fruit removed 147.8 kg N, 19.8 kg P and 156.2 kg K. Large variations between Watermelon varieties in Nitrogen (N) uptake were reported by Chakraborty, Maiti and Chattopadhyay. (2010). They reported that varieties "*Citrullus battichForssk* absorbed 20.8N, 87.6N, 421.9N and 672.2N per plant at 6, 33, 47 and 58 days after planting".

The period of greatest nutrient requirements for N, P and K is from about ten days after flowering to just before the fruit begins to ripen. There is diurnal variation in nutrient absorption. A higher proportion of P tends to be absorbed during the night than N or K. (Atherton and Rudich, 2010: 143). For efficient production, Watermelon requires nutrient

management that will enhance its growth potential. Hanson (2012). Watermelon plants should be fertilized with organic (animal manure) and/or chemical fertilizers to produce high yields. The total N (kg per hectare) required to achieve a target fruit yield is estimated by multiplying the target yield in tons per hectare by 2.4. Requirements (kg per hectare) of P_2O_5 and K_2O are estimated by multiplying N uptake by 0.35 and 1.45, respectively.

Commercial farmers sometimes forecast a target yield and calculate the fertilizer requirements for achieving the yield (Len *et al.*, 2019:270). Usually, the total nutrient requirement is a composite of the nutrients in the soil and the nutrients supplied by the farmer from organic and inorganic sources.

The NPK 15:15:15 already in the soil will provide part of the nutrient requirement, and the actual amount of soil nutrients can be estimated by a laboratory soil test. When the soil nutrient quantity is established, addition of fertilizer is needed to make up the difference between the NPK 15:15:15 fertilizer requirement for the target yield and NPK 15:15:15 fertilizer available in the soil (Hanson *et al.*, 2010). However, fertilizer uptake efficiency by a crop is highly variable and depends upon many factors including fertilizer form and placement (surface versus incorporated versus banded), as well as irrigation and other management practices (Athorn and Rudich, 2019:38). In the tropics, common fertilizer application rates are 60-120 kg N per hectare, 60-140 kg P_2O_5 per hectare, and 60-120 kg K_2O per hectare.

2.3 Agronomic practices of watermelon plants

2.3.1 Land preparation

Land preparation is clearing and removal of bushes on the surface of the land, this is performed differently, but the two main practices are, one or two ploughing followed by harrowing. The size of the land, costs and machines available dictate the methods to use for land preparation.

2.3.2 Nursery bed preparation

A nursery bed is a place of high land for raising seedlings and is made with pillar bricks and furrows. It is just like a seedbed. This place is selected for the planting of cutting, layers, grafts instead of seed sowing.

2.3.3 Nursery bed management

Nursery management may be defined as the sum of the activities performed for the successful production, care, and marketing of different planting materials (seeds, seedlings, cuttings, etc.) in a different nursery section. Conducting employees properly, maintenance care and protection of properties, etc.

2.3.4 Manure/fertilizer application

Fertilizers are generally defined as "any material, organic or inorganic, natural or synthetic, which supplies one or more of the chemical elements required for the plant growth." Most fertilizers that are commonly used in agriculture contain the three basic plant nutrients: nitrogen, phosphorus, and potassium.

2.3.5 Weed control/weeding

Weeding is the process of removing unwanted plants from a field. The agricultural field is weeded primarily using two methods: tilling and mowing. Weed plants are tilled completely with their roots and removed during tilling. Mowing is the process of removing unwanted plants from a field.

2.3.6 Staking

Staking is a means of providing supports to ensure clean and unblemished fruits by keeping fruits off the ground, thereby increasing marketable yield.

2.3.7 Pest and disease control

Pest control in agriculture are chemical (pesticides, fungicides, herbicides), biological (the introduction of the natural enemy to the pest), and natural (manual removal or the use of fences) methods. Pest control is the regulation or management of a species defined as a pest;

such as any animal, plant or fungus that impacts adversely on human activities or environment.

2.3.8 Growth period and harvesting

Plants' lives may be as short as a few weeks or months, but they go through distinct changes as they grow, just as people do. The stages that plants go through are from seed to sprout, then through vegetative, budding, flowering, and ripening/picking stage.

2.3.9 Handling after harvest

In agriculture, postharvest handling is the stage of crop production immediately following harvest, including cooling, cleaning, sorting and packing.

2.4 Agronomic benefits and effect of NPK (15:15:15) fertilizer on watermelon plant

Nitrogen, the N in NPK, is of outstanding importance among the essential elements in that nitrogen compounds comprise 40 to 50% of the dry matter of protoplasm and the living substance of plant cells. For this reason, Aliyu (2010) notes that: "Nitrogen is required in relatively large quantities in connection with all growth processes in plants." It follows directly from this that without an adequate supply of nitrogen appreciable growth cannot take place and that plants may remain stunted and relatively undeveloped when nitrogen is deficient (Botiano, and Mokwunye, Grubben, *et al.*, (2014) maintains that: "Nitrogen helps plant foliage to grow strong."

According to Len *et al.*, (2019), "Much of the energy required for plant metabolism is stored chemically in the form of complex Organic phosphates and is released, as required, to drive the chemical process involved in growth." The significance of phosphorus is pronounced during the early and mature periods of a plant's production cycle. Nurung (2010) claims that: "Phosphorous helps roots and flowers grow and develop." This is corroborated by Clerk (2018) who argues that Phosphorus is essential for seed germination and root development. It is needed particularly by young plants forming their root systems and by fruit and seed crops. Root vegetables such as carrots, swedes and turnips obviously need plentiful phosphorus to develop well.

The consequences of the deficiency of phosphorus also underscore the necessity of the element in the productivity of plants. John *et al.*, (2014) observed that “Without ample phosphorus you will see stunted growth, probably a purple tinge to leaves and low fruit growth and yields”.

The last element in the NPK fertilizer is the potassium. Potassium, the K in the NPK is unusual among the macronutrients. It makes no direct contribution to the cellular structure of plants (Hedge, 2014). Its main function appears to be that of a regulator for many of the metabolic processes in the cells, including protein synthesis. In the opinion of Smith (2014) “Potassium (Potash) is important for overall plant health.” However, the presence of potassium in plants is traceable to certain more specific consequences. Hedge and Srinivas (2010), for example, asserts, “Potassium promotes flower and fruit production and is vital for maintaining growth and helping plants resist disease.” Likewise, Hedge (2014) states, “Potassium is used in the process of building starches and sugars, so it is needed in vegetables and fruits. Carrots, parsnips, potatoes, Watermelon and apples all need plenty of potassium to crop well”. Potassium deficiency also declares its importance. Hegde and Srinivas claim that Potassium deficiency somewhat restricts growth and cause yellowing of the margins of the upper and middle leaves.

2.5 Agronomic benefits and effects of cow dung on watermelon plants

According to Aini and Vimala (2012), “Cow dung manure is the decayed, stable end product of the decomposition of cow.” Cow dung manure has long been recognized as a desirable organic fertilizer because it contains many of the elements required to grow plants (Altunga, 2017).

Beckman (2013) concludes that, “The use of cow dung manure application enhances soil productivity, increases the soil organic carbon content, soil micro-organisms, improves soil crumb structure, the nutrient status of the soil and enhances crop yield.” Adediran *et al.*, (2013). Compared cow dung manure, household, market and farm waste and found that cow dung manure at 20 t/ha had highest nutrient contents and mostly increased growth and yield of Watermelon and soil macro and micronutrients content. Akande and Adediran (2014),

found that cow dung manure at 5t/ha⁻¹ significantly increased Watermelon and dry matter yield, soil pH, N, P, K, Ca and Mg and nutrient uptakes.

Aluko and Oyedele (2011), found little information on the effects of organic waste on soil physical properties and they observed that cow dung manure incorporation had no significant effect on soil density and porosity.

Cow dung manure however does not affect all plants in the same way. Among the crops which make the most efficient use of cow dung manure are sweet corn, pepper, eggplant, cantaloupe, cucumber, watermelon, squash, and pumpkin (Jake, 2016:142).

Similarly, Comparison of several organic nutrient sources on the yield of lettuce in Cameron Highlands showed that poultry-manure as the sole source of nutrients gave yields equivalent to cow dung manure + NPK. The other entire organic source gave lower yields compared to organic source + NPK (Vimala *et al.*, 2011), studied the effect of five phosphorous levels (0, 25, 50, 75, 100 and 125 kg/ha) and five cow dung levels (0, 100, 200, 300, 400 and 500 kg/ha) on the growth, growth yield, yield components, nutrients concentration and food values of pepper (*Capsicum annuum L.*). Alabi (2016) notes: "Application of organic waste, cow dung increased the growth and yield components of watermelon significantly more than the fertilizer phosphorus, while cow dung manure is considered a suitable source of plant nutrients, the use of the manure in combination with NPK is thought to have a synergistic effect. John *et al.*, (2014) advocate, "An integral use of organic manure and inorganic fertilizers to sustain maximum crop productivity and profitability, while minimizing environmental impact from nutrient use".

2.6 Related Empirical Studies

Plant response to NPK 15:15:15 has been investigated with relatively consistent results – growth and yield improvement. However, the optimum quantity and the proportion of the macronutrients in NPK that maximizes growth and yield have varied from plant to plant and experiment to experiment. Many investigators reported that the vegetative growth of onion plants and minerals uptake was increased by increasing the level of NPK-fertilizers. Moreover Haggag, Rizk, Hagra, and El-Hamed, reported that total bulb yield and bulb

quality of onion plant were improved by increasing the level of NPK 15:15:15 fertilizers. Law-Ogbomo and Remison (2017) gave 100, 200, 300 and 400kg ha⁻¹ respectively of NPK fertilizer to *Dioscorea rotundata* in Edo state, Nigeria.

The treatments were arranged in randomized complete block design in three replicas. They found that the vine length, number of leaves, and leave area index significantly increased as fertilizer application increased thereby resulting in higher yield (Law- Ogbomo, and Remison, 2017:922). Working on Watermelon plants in Nigeria and China (2016) found “higher levels of fertilizer (120kg N, 80kg P₂O₅, and 160kg K₂O per hectare) application produced significantly taller and broader Watermelon plants, higher number of fruits per plant, and higher total yield over the no fertilizer added plots.” In their investigation, Dehoet al., (2012) sowed seeds of Phulkora variety of onion in a nursery of loamy soil, divided into three plots of six beds each. They treated the plots with different ratios of NPK and observed randomly selected plants, at the peak of the plants' height. They found no significant differences in the heights and bulb diameters of the plants in the six plots; but they found a direct relationship between the proportion of N in the different treatments and the weight of plants, number of leaves per plant, fruit volume, and fruit yield. Studies conducted on cow dung manure suggested that the manure is a suitable nutrient source for vegetable crops. Aliyu (2010) reported that the use of farm yard manure (FYM) plus Cow dung manure at 5t ha⁻¹ resulted in higher fruit yield of egg plant. The results showed that application of Cow dung manure significantly enhanced growth and yield parameters, vigour and number of fruits during the two seasons, Aliyu, conducted two field experiments during the early growing season of 2012 and late season of 2013 in Ibadan, Nigeria.

The plant height and leaf area per plant were not significantly affected by raising the number of plants per stand from one up to three; while application of different rates of cow dung manure had significant effect on plant height, number of leaves and branches, leaf area and dry matter distribution per plant.

A field experiment conducted by Ayoola and Adeniyen (2014) to determine the optimal rate at which decomposed cow dung manure would maximize muskmelon yield under Seychelles conditions added more evidence to the positive response of vegetable crops. The experiment

which was replicated four times in a randomized complete block design consisted of five treatments; an untreated control and four levels of decomposed cow dung manure (DPCM) at 10, 20, 30 and 40 t/ha. Results of the study showed that all DPCM treatments significantly improved number of fruits, fruit length, fruit weight, and yield, which improved the most with the 30 t/ha DPCM treatment (Ayoola, and Adeniyani, 2017). “The growth and yield and quality of Watermelon fruits produced with cow dung manure are comparable with those obtained using mineral N fertilizer. Cow dung manure can therefore be a suitable replacement for inorganic fertilizer in Watermelon production.

The experiment involved treatments that consisted of two levels of urea (0 and 60 kg.N ha⁻¹) and five levels of cow dung manure (Pm) (0, 3.0, 4.5, 6.0, 7.5 t. ha⁻¹). Olaniyi and Ajibola (2008) observed: “...plant height and number of leaves showed increasing response as the amount of fertilizer applied increased.” The yield and nutritional quality of Watermelon fruits were significantly improved by the application of sole cow dung manure and mineral N fertilizer at 6.0 t. pm and 60 kg. N ha⁻¹ (Olaniyis and Ajibola, 2010).

2.7 Summary of Literature Review

Watermelon, which acquired its name from edible fruit, a word in the Nahuatl language in the Americas, belongs to the family Citrullus and the genus lanatus. Its botanical name is *Citrullus lanatus*. While it probably originated in South America, it is grown all over the world. Varieties such as Anguriacitrullus Mill, Citrullus amarus Schrad, Citrullus anguria (Duchesne) H.Hara, Citrullus aquosus Schur, Citrullus battichForssk and Citrullus caffer Schrad exist in Nigeria.

The Watermelon plant is an annual or a short-lived Berennial dicot, although it is always cultivated as an annual crop. The Watermelon requires a number of physical and chemical conditions to produce optimally. The Watermelon plant grows well under a range of soil properties from sandy to fine-textured loamy. The Watermelon plant grows well within a soil PH range of 5.5 to 6.8, with optimum range being 6.0 and 6.5. Considered moderately sensitive to salinity, the Watermelon plant can tolerate a salinity level of up to 2.5 dissolve salt/meter without significant yield loss. The Watermelon plant has a high requirement for

the elements K and Ca and the micronutrients Fe, Mn, and Zn; and has a medium requirement for the elements N, Mg, P, S and the micronutrient Cu For efficient production. Watermelon plants vary in their yield potentials. Although the genetic yield potential for the Watermelon plant is not known, the observed differences in yield capacities are at times traceable to the different varieties and different cultural techniques. The spacing for Watermelon actually depends on many factors which among others include soil condition, soil fertility, climate, cultivar, methods of planting, incidence of diseases and insect pests. Closer spacing (30cm btw plants and 60cm btw rows) resulted in higher yield and less cracked fruit per plant.

Nitrogen, Phosphorus, Potassium (NPK) are the three elements essential for growth and yield in plants. Most compound fertilizers contain NPK. NPK are among the class of plant nutrients called the macronutrients. The proportions of NPK in a compound fertilizer are represented by numbers. The three numbers listed on fertilizer labels correspond to the percentage of these materials found in the fertilizer. Each of these identified essential elements play significant roles in promoting the growth and yield of plants.

Nitrogen, the N in NPK, is of outstanding importance among the essential elements in that nitrogen compounds comprise 40 to 50% of the dry matter of protoplasm and the living substance of plant cells. Another important element in the NPK fertilizer is phosphorus. Phosphorus, the P in NPK, provides plants with a means of storing energy for their metabolic process. Much of the energy required for plant metabolism is stored chemically in the form of complex Organic phosphates and is released, as required, to drive the chemical process involved in growth. The last element in the NPK fertilizer is the potassium. Potassium, the K in the NPK, is unusual among the macronutrients.

Interestingly, the nitrogen component of cow dung manure is relatively average and Nitrogen is particularly needed by plant in relatively high quantities. The use of cow dung manure application enhances soil productivity, increases the soil organic carbon content, soil micro-organisms, improves soil crumb structure, the nutrient status of the soil and enhances crop yield. In addition to increasing the soil fertility, cow dung manure amends the soil by adding organic matter to the soil. Cow dung manure provides plants with more good nutrients than most organic fertilizers while cow dung manure is considered a suitable source of plant

nutrients, the use of the manure in combination with NPK is thought to have a synergistic effect. Plant response to NPK has been investigated with relatively consistent results.

3.0 MATERIALS AND METHODS

3.1 Experimental Area

The experiment was conducted in Bauchi, Bauchi State, Nigeria. The State is located between latitudes 9° 3' and 12° 3' North and longitudes 8° 50' and 11° 0' North-Eastern part of the Nigeria has a total land area of 49,119Km² representing about 5.3% of the country's total land mass and extents too distinct vegetation zones namely the Sudan Savannah and the Sahel Savannah (Mustapha and Ahmed 2015). The present study was conducted inside plant nursery of Forestry Technology Department of Federal Polytechnic Bauchi, Bauchi State.

3.2 Research Design and Treatments

The experiment was conducted on an open field during the raining season of 2023 inside Plant Nursery of Forestry Technology Department, Federal Polytechnic, Bauchi, Bauchi State. The experiment was carried out in a randomized complete block design [RCBD] with three replicates. The experiment consists of four treatments including control, cow dung manure, N.P.K (15:15:15) fertilizer and the combination of Cow dung manure and N.P.K (15:15:15) fertilizer.

3.3 Experimental Procedures

The sampling of this study is consisted of one farm using two different fertilizers [N.P.K (15:15:15) fertilizer and cow dung] a hand hoeing was used. The applied quantity of N.P.K (15:15:15) fertilizer is based on the recommendation rate of 400Kg per hectare and that of Cow dung at 7.5 tonnes per hectare, that is 0.71Kg per plot and that of cow dung at 13.2Kg per plot.

Watermelon plant variety (Crimson sweet watermelon *Citrulluslanatus*) was planted and grown in a field of sandy loamy soil. Plant seeds were directly seeded (dibbling) to the field and hand weeding was carried out regularly throughout the growing season. Pest control was also carried out against Aphids and cutworms using Cypermethrin spray.

3.4 Data Collection

The data collected was carried out from 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 weeks after sowing (W.A.S) on the following growth and yield parameters:

3.4.1 Vine Length (cm)

One plant is randomly tagged per plot. From 1 WAS to 6 WAS the length of the tagged plant was measured in centimeters from the ground level to the tip of the plant using a meter rule. Mean height per plant was determined and recorded.

3.4.2 Number of Leaves per Plant

This was taken by counting the total number of the leaves of the tagged plant at 1, 2, 3, 4 and 5 WAS from the tagged plants and the mean was determined and recorded.

3.4.3 Leaf Area (cm²)

This was taken by measuring the length and breadth of the tagged plant multiplied by (0.57) as described by Swart et al., (2004) at 1, 2, 3 and 4 WAS and later the mean was determined and recorded.

3.4.4 Number of Branches per Plant

This was taken by counting the total number of branches at 3, 4 and 5 WAS from the tagged plants and later the mean was determined and recorded.

3.4.5 Number of Flowers per Plant

This was taken by counting of the flowers at 4, 5, 6, 7 and 8 WAS from the tagged plants and the mean was determined and recorded.

3.4.6 Number of Fruits per Plant

This was taken by counting of the fruits at 5, 6, 7, 8, 9 and 10 WAS from the tagged plants and the mean was calculated per treatment basis.

3.5 Method of Data Analysis

All the data collected was subjected to one-way analysis of variance [ANOVA] All statistical calculations were performed using SPSS software. Means comparison between treatments were performed by the least significant difference (L.S.D) using Duncan's Multiple Range Test (D.M.R.T). All statistical calculations were performed using SPSS software. Statistical significance was indicated at a probability level of $P \leq 0.05$.

4.0 RESULTS AND DISCUSSIONS

4.1: Vine Length (cm)

The results obtained from the table below shows that at 1WAS there was significant ($P \leq 0.05$) difference of the vine length in response to all the treatments including control, but there were significant ($P \leq 0.05$) difference at 2WAS, where we obtained it (25.83a), (20.73ab), (17.73b) and (17.37b) application of combination of the fertilizers, NPK (15:15:15) cow dung manure and control respectively, we also obtained (62.00a), (32.57b), (30.00b), and (20.00c) for combination of the fertilizers NPK (15:15:15), cow dung manure and control at 3WAS, respectively. At 4WAS we then obtained (118.67a), (93.436b), (70.00c), and (43.67d) for the combination of the fertilizers, NPK (15:15:15), cow dung manure and control respectively. At 5WAS we obtained (134.33a), (107.67ab), (97.37b) and (68.67c) for the combination of the fertilizers, NPK (15:15:15) and control respectively. There was also ($P \leq 0.05$) difference at 6WAS in which we obtained (196.07a), (141.50ab), (92.43b) and (65.83b) for combination of both fertilizers, NPK (15:15:15), and control respectively. Generally the result shows that combinations cow dung manure is best for watermelon vine length development of all the growth stage. This work is in line with the report made by Alabi (2016) noted out that “Application of organic waste, cow dung manure is considerate a suitable source of plant nutrient, the use of the manure in combination with NPK is thought to have a synergetic effect. And in line with work of John et al., (2014) who advocated that “An integral use of organic manure and inorganic fertilizers to sustain maximum crop productivity and profitability, while minimizing environmental impact from nutrient use”.

Table 4.1: Vine Length (cm)

Treatments	1WAS	2WAS	3WAS	4WAS	5WAS	
6WAS						
Variables						
NPK (15:15:15)	10.00	20.73ab	32.57b	93.43b	107.67ab	141.50ab
Cow dung manure	5.83	17.73b	30.00b	70.00c	97.37b	92.43b

Combination of NPK and CDM	9.40	25.83a	62.00a	118.67a	134.33a	196.07a
Control	7.83	17.37b	20.00c	43.67b	68.67c	65.83b
S.E	2.05	2.69	4.09	6.90	12.07	40.02
L.S.D	N.S	*	*	*	*	*

WAS = Weeks after sowing

CDM = Cow dung manure

S.E = Standard Error of means, N.S means there is no significant difference

L.S.D = Least Significant Difference at 5% level of probability,

* = There is significant difference at 5% level of probability.

Means followed by the same letter are statistically similar at 5% level of probability

4.2 Number of Leaves Per Plant

The result obtained revealed significant difference ($P \leq 0.05$) in terms of the number of leaves per plant from 3WAS in response to the application of nutrients to the watermelon plant, this indicated that combination of NPK (15:15:15) and cow dung manure gives better result followed by the other treatments (i.e NPK (15:15:15) and cow dung manure. This result conforms the work of Olaniyi and Ajibola (2018) who observed that: “Plant height and number of leaves showed increasing response as the amount of fertilizer increased”, and in contrast with the results of Ayoola and Adeniyi (2017), who reported that “The growth and yield quality of watermelon fruits produced with cow dung manure are comparable with those obtained using mineral N fertilizer”.

Table 4.2: Number of Leaves Per Plant

Treatments	1WAS	2WAS	3WAS	4WAS	5WAS
Variables					
NPK (15:15:15)	4.00	5.00	9.33ab	19.33ab	27.00ab
Cow dung manure	3.33	5.00	9.67ab	20.33ab	25.00ab
Combination of NPK and CDM	3.67	5.67	11.67a	23.67a	35.33a

Control	3.00	4.67	6.33b	11.33b	17.33b
S.E	0.52	0,78	1.43	3.90	5.62
L.S.D	N.S	N.S	*	*	*

WAS = Weeks after sowing

CDM = Cow dung manure

S.E = Standard Error of means, N.S means there is no significant difference

L.S.D = Least Significant Difference at 5% level of probability,

* = There is significant difference at 5% level of probability.

Means followed by the same letter are statistically similar at 5% level of probability

4.3: Leaf Area (cm²)

The result from the table showed significant ($P \leq 0.05$) difference among the treatments, the combination of NPK (15:15:15) fertilizer with cow dung manure gives the best result compared to the application of either of the sole NPK (15:15:15) fertilizer or cow dung manure. This result is in conformity with the findings of Aliyu (2010) who reported that “The use of farm yard manure plus cow dung at 5tonnes per hectare resulted in higher fruit yield of eggplant. And in contrast with the result of Aliyu (2012 and 2013) who pointed out that the plant height and the leaf area per plant were not significantly affected by raising the number of plant per stand from one up to three”.

Table 4.3: Leaf Area (cm²)

Treatments	1WAS	2WAS	3WAS	4WAS
Variables				
NPK (15:15:15)	12.98b	33.43ab	99.78ab	150.46
Cow dung manure	10.69bc	34.75ab	87.27b	124.07
Combination of NPK and CDM	19.95a	51.53a	140.81a	179.99
Control	6.70c	17.15b	32.99c	81.48
S.E	2.33	12.26	19.99	42.03

L.S.D * * * N.S

WAS = Weeks after sowing

CDM = Cow dung manure

S.E = Standard Error of means, N.S means there is no significant difference

L.S.D = Least Significant Difference at 5% level of probability,

* = There is significant difference at 5% level of probability.

Means followed by the same letter are statistically similar at 5% level of probability

4.4: Number of Branches Per Plant

The result obtained revealed that the significant ($P \leq 0.05$) difference only existed at 4WAS among the treatments, this shows that the number of branches of watermelon plant responds to the fertilizer application at 4WAS. Generally, watermelon number of branches increase with the application of both the NPK and cow dung manure sole application of either of the cow dung manure or NPK. This result contrasts the report of Botiano, and Mokwunye, Grubben, et al., (2014) who maintained that “Nitrogen fertilizer help plant foliage to grow strong, and proves the observation of John et al., (2014) who observed that “without ample Phosphorus you will see stunted growth, probably a purple tinge to leaves and low fruits growth and yields.

Table 4.4: Number of Branches Per Plant

Treatments	3WAS	4WAS	5WAS
Variables			
NPK (15:15:15)	6.00	15.33ab	20.67
Cow dung manure	6.00	16.33ab	19.33
Combination of NPK and CDM	9.33	23.67a	29.67
Control	2.67	4.67b	12.67
S.E	3.31	6.09	7.84
L.S.D	N.S	*	N.S

WAS = Weeks after sowing

CDM = Cow dung manure

S.E = Standard Error of means, N.S means there is no significant difference

L.S.D = Least Significant Difference at 5% level of probability,

* = There is significant difference at 5% level of probability.

Means followed by the same letter are statistically similar at 5% level of probability

4.5: Number of Flowers Per Plant

The result obtained revealed that significant ($P \leq 0.05$) difference exist at 5 and 6 WAS of watermelon plant number of flowers in response to the combination of NPK (15:15:15) fertilizer in cow dung manure, NPK alone and cow dung manure alone. This shows that the combination of the two fertilizers types gives the height numbers of flowers per plant followed by NPK and subsequently cow dung manure. This result is in line to the work of Vimala *et al.*, (2011) who stated that “The other entire organic source (Including cow dung manure) gives lower yields compared to organic source plus NPK”.

Table 4.5: Number of Flowers Per Plant

Treatments	4WAS	5WAS	6WAS	7WAS	8WAS
Variables					
NPK (15:15:15)	1.00	3.33ab	6.67ab	10.00	5.33
Cow dung manure	1.33	2.67ab	3.67ab	5.00	2.00
Combination of NPK And CDM	2.67	5.67a	7.67ab	9.33	5.00
Control	0.67	1.33b	2.67b	4.00	2.00
S.E	0.91	1.55	2.01	3.19	1.65
L.S.D	N.S	*	*	N.S	N.S

WAS = Weeks after sowing

CDM = Cow dung manure

S.E = Standard Error of means, N.S means there is no significant difference

L.S.D = Least Significant Difference at 5% level of probability,

* = There is significant difference at 5% level of probability.
Means followed by the same letter are statistically similar at 5% level of probability

4.6: Number of Fruits Per Plant

The result presented in table 4.6 indicated that the application of both the NPK (15:15:15) fertilizer and cow dung manure, only NPK (15:15:15) fertilizer and only cow dung manure gives significant ($P \leq 0.05$) differences from 5 to 10 WAS, with the combination been with highest impact, followed by NPK (15:15:15) fertilizer and then cow dung manure only, and lastly the control. This result is in agreement with the findings of Vimala et al., (2011) who pointed out that the entire organic source gave lower yields compared to organic source plus NPK, and with the experiment result of Olaniyi and Ajibola (2010) who pointed out that “The yield and nutritional quality of watermelon fruits were significantly approved by the application of sole cow dung manure and mineral N fertilizer at 6.0t/pm and 60Kg N per hectare.

Table 4.6: Number of Fruits Per Plant

Treatments	5WAS	6WAS	7WAS	8WAS	9WAS	10WAS
Variables						
NPK (15:15:15)	2.00ab	3.33ab	4.67a	6.33a	8.67a	10.67a
Cow dung manure	2.00ab	4.00ab	5.33a	6.33a	7.33ab	9.33ab
Combination of NPK And CDM	3.33a	3.67a	6.00a	7.67a	8.67a	11.33a
Control	0.33b	1.33b	2.00b	3.00b	3.67b	5.33b
S.E	0.78	1.08	1.05	1.35	1.59	1.79
L.S.D	*	*	*	*	*	*

WAS = Weeks after sowing

CDM = Cow dung manure

S.E = Standard Error of means, N.S means there is no significant difference

L.S.D = Least Significant Difference at 5% level of probability,

* = There is significant difference at 5% level of probability.

Means followed by the same letter are statistically similar at 5% level of probability

5. 0 SUMMARY, CONCLUSION, RECOMMENDATIONS

5.1 Summary

This research work was conducted to find out the effects of NPK (15:15:15) and Cow dung manure on growth and yield of Watermelon plants cultivated on experimental plots on natural soil in Bauchi Local Government Area of Bauchi State. To do this, four research questions were asked and their answers were sought using an experimental design known as Randomized Complete Block Design (RCBD). This design involved four experimental blocks each with three replicates. While the design provided answers, the answers were recorded using an observation schedules.

The data generated from the recorded observations were analyzed using Spss Software, also two hypotheses were tested using a one-way Analysis of Variance (ANOVA). The findings that emerged from the analyses and the test of the hypotheses showed that NPK (15:15:15) plus Cow dung combined treatment was more effective than individual N.P.K (15:15:15) treatment; NPK (15:15:15) only treatment was more effective than sole Cow dung treatment; and Cow dung only treatment was more effective than the no nutrient added treatment in promoting the yield of Watermelon plants grown on the experimental plots in natural soil in Bauchi Local Government Area of Bauchi State. The First three treatments were each more effective than the control treatment of no nutrient added by a wide gap. Similarly, the effect of NPK15:15:15 and Cow dung combined treatment was significantly higher than the individual effects of the other three treatments. However, the difference in the effectiveness of the NPK15:15:15 only treatment over the effectiveness of the Cow dung only treatment was narrow. This showed that farmers can rely on the use of other organic manure such as poultry droppings for the production of Watermelon in the absence of mineral fertilizer.

5.2 Conclusion

Based on the findings of this research, results presented rejects the null hypothesis that stated there are no significant differences among NPK (15:15:15), Cow dung, and the combination of NPK (15:15:15) and Cow dung in their effects on the yield of Watermelon plants grown on experimental plots in natural soil in Bauchi State a Local government Area of Bauchi

State. Solely on the basis of the data generated, the analyses carried out on them, including the tests of hypotheses and the findings extracted from the test and the analyses, it is concluded that there were significant differences among NPK (15:15:15) fertilizer, Cow dung manure, and the combination of NPK (15:15:15) with Cow dung in their effects on the growth and yield of Watermelon plants grown on experimental plots in natural soil in Bauchi Local Government Area of Bauchi State. It is also concluded that the yield of the experimental Watermelon plants responded differently to each of the different experimental treatments.

5.3 Recommendations

Based on the findings of this research work and the conclusion drawn, it is recommended that:

- i. This research work is made available to the supervising ministries and extension workers of the Fadama projects in Bauchi Local Government Area of Bauchi state, Nigeria. The relevant ministry officials and Fadama extension workers should study the findings and use them to help the participants and farming cells of the Fadama project to improve their yields, especially those of Watermelon plants. On the basis of these findings, the Fadama project officials and extension workers should sensitize participating cells and individuals of the advantage of using Cow dung as an alternative nutrient source in the face of scarce and expensive commercial fertilizers. Besides, they should encourage the participants to consciously gather, buy and conserve Cow dung which are generated in homes and farms for their farming purpose.
- ii. The owners and managers of large vegetable farms who cultivate Watermelon plants should not rely on commercial fertilizers alone, but also use Cow dung, especially in complementary applications, to improve both their yields and their soil. They should study the findings of this research work to appreciate the advantages of integrating Cow dung into their farm's nutritional management.
- iii. Further researches using different levels and types of fertilizers can be carried out to ascertain the present findings and the scope of the research in the study area.

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**ASSESSMENT OF THE LEVEL OF INTELLIGENT TRANSPORT SYSTEMS (ITS)
AWARENESS AMONG ROAD USERS IN MINNA METROPOLIS**¹Abubakar, Ibrahim Damana,²Ojekunle, Joel Ademola,Lead author: ¹ibrahimdamana2015@gmail.com/+2347016983859^{1&2} Department of Logistics and Transport Technology, School of Innovative Technology,
Federal University of Technology, Minna.**ABSTRACT**

Traffic problems are increasingly becoming a concern in urban centers worldwide, with Minna, Nigeria, being no exception. As the city expands and urbanizes, its road infrastructure is put under tremendous pressure, leading to delays, safety concerns, increased pollution, and subsequent socio-economic impacts. While numerous traditional methods have been deployed to alleviate these concerns, the emergence of the Intelligent Transport System (ITS) offers a technologically advanced solution that promises a more holistic approach to traffic management. The foregoing study aimed to assess the level of awareness of Intelligent Transportation Systems (ITS) among road users in the Minna metropolis. The Selection of the sample was by stratified random sampling, taro Yamane's formula was adopted to determine a sample size of 400. The descriptive statistics reveal diverse road user characteristics with a skew towards male respondents and significant variability in road user categories. The regression model further reveals a strong correlation ($R: 0.922$) between predictors and ITS awareness. High R Square (0.849), indicating that 84.9% of the variance in ITS awareness is explained by the predictors. Adjusted R Square (0.847) is also high, confirming a robust fit. Standard Error of the Estimate: 0.484 , indicating prediction accuracy. Significant F Change (455.076 , $p < 0.001$), indicating the model is statistically significant. The study concludes that ITS awareness in Minna Metropolis is currently low. It is recommended that the awareness campaign should focus on younger and less educated populations who demonstrated a low level of awareness.

Keywords: Intelligent, Management, Transport, Technology, Traffic**1.0 Introduction**

Over the years, transport has offered numerous benefits to humans and has facilitated the movement of people and the distribution of finished products from one geographical location to another through various modes of transport. Road transport particularly, has enabled humans to access quality destinations. The increasing migration of people from rural areas to urban centers in Nigeria to access basic amenities has increased in urban populations. Rapid urbanization and the inability of the available public transport system to meet the demand resulted in the increasing use of private vehicles on the road. The resultant decision to use private vehicles to satisfy mobility needs causes traffic challenges in major cities in Nigeria such as traffic congestion, road accidents, environmental pollution, inadequate security, and traffic violations by road users. Hence, a need for the application of an Intelligent Transport System (ITS) to manage these traffic challenges.

ITS uses advanced communications, computer, and information technologies to improve the safety and efficiency of transportation systems (Patel, *et al.*, 2005). Osipitan (2014) noted that ITS technology has been recommended by researchers to manage traffic challenges. Intelligent Transport Systems (ITS) are only effective at enhancing road user's safety if and when they are accepted by the users. Larue *et al.* (2015) defined user acceptance as a prospective user's sensitivity towards using a certain system.

Modern transport systems aim to achieve an optimal flow of goods and people from one place to another, which has a significant impact on the quality of life in any society. Technological advancement across the various transport modes, increases in population and changes in population density, increasing motorization and urbanization in metropolitan areas have resulted in contemporary problems in the management of modern transport systems. Poor traffic organization causes much traffic congestion, hindering the efficient use of transport infrastructure and increasing travel time, air pollution, and fuel consumption. Successful implementation of Intelligent Transportation Systems (ITS) requires a good understanding of both local and global phenomena, such as the extent of traffic congestion and environmental pollution. Human perceptions are also an essential factor that must be taken into consideration when adopting ITS (Kołodziej *et al.*, 2022).

Previous studies in Nigeria by Osipitan (2014); Olasupo *et al.*, (2021); Adeleke *et al.*, (2016); and Amadi *et al.*, (2014) were centered on highlighting the various applications of ITS, its benefits and challenges. However, the success of the implementation of ITS in Nigeria particularly in Minna Metropolis will depend on so many factors relating to the adopters. The challenges affecting the adoption of technology in developing countries depend on factors such as hardware incompatibility and complexity; language barriers, the lack of regular electric supply, computers, Internet access, and lack of practical training for traffic facilitators (Jayson, 2011). Other factors that may prohibit the adoption of ITS technology include the unwillingness of the users to use the technology, poor compliance attitudes, and inadequate enforcement officers to watch violations. It's against the background the study seeks to study the road users' awareness of the Intelligent Transport System (ITS) in managing road traffic problems in Minna Metropolis.

The foregoing study aimed to assess the level of awareness of Intelligent Transportation Systems (ITS) in managing road traffic problems among road users in the Minna metropolis. This was achieved by identifying the types of ITS technologies familiar to road users in Minna Metropolis; evaluating the frequency of ITS usage by the road users; and examining the potential benefit of ITS.

2.0 Literature Review

2.1 Conceptual Framework

The increasing globalization and technological advancement have increased the number of scientific research on intelligent transport systems. Researchers study the application of ITS in different subsectors of the transport industry. There is no single definition of the concept of ITS, and many authors define it in their research based on documents, standards, and other research related to the transport system and ITS. However, almost all ITS definitions identified in many research highlighted ITS as the application of information and communication technology, which uses infrastructure or vehicles and performs specific functions such as traffic management, safety enhancement, mitigation of pollution and congestion, improvement of the overall transport system efficiency and transport service quality (Neverauskienė *et al.*, 2021).

Intelligent Transport System (ITS), encompasses a variety of systems and applications deployed to address many transport problems. ITS, also known as smart transport is a concept that has been widely used in solving transport problems since the 1990s, with many academic professionals and industrial applications in improving the efficiency of transport activities (Mitchel, 2012; Salisu, *et al.*, 2020). According to Salisu *et al.* (2022), the concept of ITS has been widely adopted and found beneficial in road traffic system management, particularly in the areas of real-time traveler information control and management; road pricing or road usage charging; smart charging for electric vehicles; vehicle-vehicle (V2V) and vehicle-infrastructure (V2I) system management; centralized city management and city logistics among others.

An Intelligent Transport System (ITS) uses sophisticated road and telecommunication infrastructure to communicate between vehicles and the highway to improve safety, and vehicle and road efficiency, as well as adequately manage traffic flow within the road network. ITS is a generic concept that covers a wider range of technological systems such as Advanced Driver Assistance Systems (ADAS), In-Vehicle Information Systems (IVIS), and Roadside Telematics (RT) (Nkoro&Vershinin, 2014). With changing times and automation of vehicles, it is becoming necessary to have technology that can safeguard people from road accidents. Cooperative - Intelligent Transport Systems (C-ITS) is an emerging field; work is being done regularly to enhance road safety. With automation, cyber security also becomes a component to be taken care of. In C-ITS, it is more necessary to provide security to vehicles as the lives of people are involved in it (Manglaet *al.*, 2023).

2.2 Theoretical Review

2.2.1 Technology Acceptance Model (TAM)

TAM was developed by Davis in 1986, TAM is one of the most influential theories used to determine users, acceptance of technology. The model highlights two key factors influencing technology adoption: perceived usefulness (the degree to which a person believes that using a particular system would enhance his/her job performance); and perceived ease of use (the degree to which a person believes that using a particular system would be free from excessive effort). In the context of ITS, TAM can be used to understand whether road users perceived the system as beneficial and easy to understand or use.

2.2.2 Diffusion of Innovation Theory (DIT)

This theory was proposed by Everett Rogers in 1962, this theory seeks to explain why, how, and at what rate new ideas and technology spread. Factors like relative advantage, compatibility, and complexity determine the adoption rate of the innovations. For ITS, this theory can provide insights into how rapidly the system might be accepted and integrated into Minna Metropolis transport infrastructures, based on the perceived attribute of the innovation.

2.2.3 Theory of Planned Behavior (TPB)

This theory is an extension of the Theory of Reasoned Action (TRA), which asserts that behavior is determined by intentions, which are shaped by attitude toward the behavior, subjective norms, and perceived behavioral control. By employing TPB, researchers can analyze how road users' attitudes towards ITS, their perception of societal pressures, and their perceived control over using or interacting with ITS might influence their intention to support or use it.

2.2.4 Social Cognitive Theory (SCT)

This theory was developed by Albert Bandura, SCT emphasizes the importance of social influence and observational learning in shaping behaviors and decisions. In the realm of ITS, SCT can be used to understand how road users perceptions and behaviors are influenced by observing others, for instance, if they see fellow drivers or pedestrians benefiting from or struggling with ITS

2.2.5 Unified Theory of Acceptance and Use of Technology (UTAUT)

This model, proposed by Venkatesh et al. in 2003, is an integration of eight models, including TAM and TPB. It identifies four key determinants of usage intention and behavior: performance expectancy, effort expectancy, social influence, and facilitating conditions. UTAUT can be particularly insightful for this study as it provides a comprehensive lens to analyze the factors influencing road users' intentions to embrace ITS.

2.3 Empirical Review and Knowledge Gap

The reviews of the literature on intelligent transport systems in managing transport problems are numerous. Touloukiet *al.* (2017) researched the benefits of ITS in Greece. The authors used a survey method and discovered that the application of ITS could increase the personal income of the population, reduce travel time, and encourage them to choose a more environmentally friendly means of transport. The authors also argue that ITS can improve the quality of public transport services. In terms of economic benefits, Vencatayaet *al.* (2018) and Neverauskienèet *al.* (2021) in their study discovered that ITS can reduce the cost of producing and trading goods and services respectively, ITS can also have a positive impact on annual income and job creation. To assess the economic benefits of ITS, the authors argue that it is important to identify the financial damage caused by the transport system. In their

study, it was also discovered that the main causes of financial damage in the transport sector are traffic congestion and traffic accidents.

Dukiya (2013) conducted research on energy shortage, climate change, and the challenge of Intelligent Transport System (ITS) Adoption in African Countries. The study assessed the Federal RoadSafety Corps (FRSC) and police operations that are ITS compliance in Abuja and Minna. The result shows that there is no modern ITS infrastructure and that about 65% of the road signaling devices are either dead or malfunctioning due to power failure. The paper concluded that African countries like Nigeria need adequate budgetary planning and manpower development for effective ITS adoption.

Ajayiet *al.* (2021) studied Transport Inequalities and the Adoption of Intelligent Transportation Systems in Africa. The review was performed to determine the state of the art of ITS in Africa. The output of this systematic review was then fed into a hybrid multi-criteria model to analyze the research landscape, identify connections between published works, and reveal research gaps and inequalities in African ITS. Another study review, on intelligent transport systems by Kashif and Abdul (2013), was conducted to tackle the great variety of Intelligent Transport System (ITS) applications, technologies, and its prospects. Shereen and Ahmed (2016) studies on the intelligent transport system in Egypt review the challenges preventing the government from possibly adopting of intelligent transport system. There exists a gap in the factors inhibiting the adoption and implementation of the technology by road users in Minna Metropolis. The foregoing research will fill this gap by investigating the road user's perception of the adoption and implementation of ITS in managing road traffic problems in Minna Metropolis.

Chukwurahet *al.* (2018) surveyed the adoption of ITS to solve traffic challenges in Enugu, Nigeria. Their study assesses the role of the Intelligent Transport System in solving the problem of traffic congestion by identifying the existing system of traffic management in Enugu Urban and determining the potential for a more effective traffic management system through intelligent transport systems. Amadiet *al.* (2014) studied a model of Nigeria's intelligent transport system in the area of advanced traveler information. The proposed model

can provide real-time pre-trip and en-route traveler information to help drivers avoid congestion and choose a timesaving and safe route.

Previous studies in Nigeria by Osipitan, O. (2014); Olasupo *et al.* (2021); Adeleke *et al.* (2016); and Amadi *et al.* (2014) were centered on highlighting the various applications of ITS, its benefits, and challenges. However, the success of the implementation of ITS in Nigeria particularly in Minna Metropolis will depend on so many factors relating to the adopters. The challenges affecting the adoption of technology in developing countries depend on factors such as hardware incompatibility and complexity; language barriers, the lack of regular electric supply, computers, Internet access, and lack of practical training for traffic facilitators (Jayson, 2011). Another factor that may prohibit the adoption of ITS technology includes the unwillingness of the users to use the technology, poor compliance attitudes, and inadequate enforcement officers to watch violations. It's against the background the study seeks to study the road user's perception of the Intelligent Transport System (ITS) in managing road traffic problems in Minna Metropolis.

A plethora of research highlighted above has reviewed the literature related to the foregoing study (road user's perception on the adoption of ITS in managing road traffic problems), with much emphasis on the application, benefits, challenges, and prospect of adoption of intelligent transport system to manage traffic problems (Dewangan *et al.*, 2017; Parmar *et al.*, 2017; and Umamaheswari, *et al.*, 2021). However, reviewed literature has shown that there exists a gap in the area of road user's perception of embracing the technology. This study has come to fill this gap, by studying the road user's perception on the adoption of ITS in managing road traffic problems in Minna Metropolis.

3.0 Methods and Procedures

3.1 Research Design

The methodology of conducting this research was through a mixed-method research design, which include the use of both qualitative and quantitative data sources. This data was generated from both primary and secondary data sources. The primary data was obtained through the use of a questionnaire administered to road users. The secondary data was obtained from various secondary sources, such as research and studies undertaken by

academic researchers, government agencies, and private organizations. The Selection of sample respondents was by stratified random sampling, taro Yamane's formula was adopted to determine a sample size of 400 approximately. A total of 400 questionnaires were designed and distributed to the respondents for data collection. A total of 328 respondents were retrieved amounting to 82% of the response. A multiple linear regression model was used to test the hypothesis. The design is chosen because it provides an appropriate methodology for opinion and perception of human behavior (Nwaogazie, 2011). The data was analyzed using Statistical Package for the Social Sciences (SPSS) version 23.

3.2 Population of the Study

The population of the study includes the road users within Minna Metropolis, namely: drivers, passengers, motorcyclists, cyclists, and pedestrians. The population of the Minna metropolis is projected by the United Nations - World Population Prospects (UNWPP), (2023) to be 496,000. Therefore a total of 496,000 population size will be considered in this research for easy assessment.

3.3 Sample and Sampling Technique

The Selection of sample respondents was by stratified random sampling. The stratified random sampling technique was adopted in the administration of the questionnaires. However, the questionnaire administrator administered a questionnaire to the road users (pedestrians, motorcyclists, and cyclists) along major roads and streets Minna metropolis, while the drivers and the passengers were randomly sampled at some selected motor parks. The questionnaire administrator also avoids the selection of respondents close to each other to minimize influence.

The following Taro Yamane's formula was adopted to determine the sample size.

$$n = \frac{N}{1 + n(e)^2} \quad (\text{Yamane, T., 1973}).$$

Where;

n=sample size

N= population size

$\alpha =$ level of significance = 0.05 confidence level

Hence;

$$n = \frac{496000}{1 + 496000(0.05)^2} = \frac{496000}{1 + 496000(0.0025)} = \frac{496000}{1241} = 399.68$$

Therefore sample size (n) for this study is 400 approximately. However, 400 copies of the questionnaires were distributed to the respondents, keeping in mind that the population size is 469,000

3.4 Nature and Sources of Data

3.4.1 Primary Data

To obtain the views of the road users on the level of awareness of Intelligent Transportation Systems (ITS) in managing road traffic problems in the Minna metropolis, a paper-pencil questionnaire was designed and administered to the road users. The data obtained from the survey was processed and analyzed using statistical techniques (SPSS) to assess whether or not the level of ITS awareness among road users will facilitate the management of road traffic problems in Minna Metropolis.

3.4.2 Secondary Data

The secondary data include a review and analysis of the existing data from various secondary sources, such as the studies undertaken by academic researchers, government agencies, and the previous report of traffic challenges in Minna Metropolis from Vehicle Inspection Officials (VIOs). The review concerning the assessment of the level of road users' awareness of Intelligent Transport Systems (ITS) in managing road traffic problems was examined by drawing on these data.

3.5 Method of Data Collection/Instrumentation

Structured close-ended and self-administered questionnaire was used to collect data on; the socio-demographic characteristics of respondents; the types of ITS technologies familiarized by road users in Minna Metropolis; the frequency of ITS usage by the road users; and the potential benefit of ITS. The study participants were assured of the confidentiality of the

information collected. The instrument adopted was a five-point Likert scale with responses ranging from strongly agreed (5), Agreed (4), Undecided (3), Disagreed (2) and, strongly disagreed (1).

3.6 Method of Data Analysis

To achieve the data analysis, both descriptive and inferential statistic was used in this research. Descriptive statistics was achieved through the use of the frequency table, while inferential statistics was achieved using a multiple linear regression model. The data was analyzed using Statistical Package for the Social Science (SPSS) version 23.

The multiple regression model formula can be expressed as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + \epsilon \quad 2$$

In this formula:

- Y stands for the predictive value or dependent variable.
- β_0 = the y-intercept (value of y when all other parameters are set to 0)
- $\beta_1 X_1$ = the regression coefficient (β_1 of the first independent variable); (X_1 , the effect that the increasing variable has on the predicted y value)
- $\beta_n X_n$ = the regression coefficient of the last independent variable
- ϵ = model variation (the amount of variation present in the estimate of y)

4.0 Results and Discussion

The descriptive and regression analysis is performed to investigate the relationships between the level of ITS awareness and various predictor variables. This analysis aims to quantify the impact of different factors such as overall ITS understanding, familiarity with ITS applications, frequency of ITS usage, and perceived benefits of ITS on the awareness levels of road users. The regression model helps in identifying which predictors significantly contribute to ITS awareness, thereby offering valuable insights for developing targeted awareness programs and policies.

Table 1: Descriptive Statistics

	Category of road users	Gender	Age	Occupation	Level of Education	Monthly Income	Length of residency in Minna	Vehicle ownership	Frequency of road usage
N	Valid	328	328	328	328	328	328	328	328
	Missing	0	0	0	0	0	0	0	0
Mean		3.41	1.27	3.00	2.39	2.55	2.40	2.45	1.89
Std. Error of Mean		.086	.025	.063	.063	.054	.067	.054	.056
Median		4.00	1.00	3.00	3.00	2.00	2.00	2.00	2.00
Mode		5	1	3	3	2	2	1	1
Std. Deviation		1.549	.447	1.135	1.139	.969	1.207	.976	1.006
Minimum		1	1	1	1	1	1	1	1
Maximum		5	2	5	5	4	5	4	5

The descriptive statistics in Table 1 above provide a detailed overview of various characteristics of road users in the Minna metropolis. All categories have 328 valid responses with no missing data, indicating a complete and robust dataset. The average value (mean) for the Category of road users is 3.41, with a high standard deviation (1.549), suggesting significant variability in the types of road users. The mode of 5 (pedestrians) indicates the most frequently occurring category of road users. The mean value for Gender is 1.27, with a mode of 1 and a very low standard deviation (0.447), suggesting that the majority of the respondents are likely from one gender (male). The mean and median age values are both 3, with a mode of 3 and a standard deviation of 1.135, indicating that respondents are generally in a middle-age group (31 years- 40 years). The mean and median occupation values are both around 2.39 and 3 respectively, with a mode of 3 and a standard deviation of 1.139, indicating that respondents' occupations are self-employed. The mean level of education is 2.55, with a median and mode of 3, suggesting that respondents have an

average education (Secondary level). The mean monthly income is 2.40, with a median and mode of 3, indicating that the income levels are moderately distributed around the central value (51,000 - 70,000). The mean length of residency is 2.45, with a median and mode of 2, suggesting that respondents have generally lived in Minna for a moderate length of time (5 – 9 years). The mean value for vehicle ownership is 1.89, with a median and mode of 2, suggesting that a significant portion of respondents own vehicle at least 1 car. The mean frequency of road usage is 1.89, with a median and mode of 2, indicating that respondents use the roads rarely.

Table 2: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.922 ^a	.849	.847	.484	.849	455.076	4	323	.000

In the context of assessing the level of awareness and understanding of Intelligent Transportation Systems (ITS) among road users in Minna metropolis, the Model Summary provides crucial insights into the effectiveness of the predictive model. The model exhibits a strong correlation (R) of 0.922, indicating a high degree of association between the predictors and the level of ITS awareness. The coefficient of determination (R Square) at 0.849 suggests that approximately 84.9% of the variance in ITS awareness can be explained by the predictors included in the model. The Adjusted R Square, accounting for the number of predictors, remains high at 0.847, indicating a robust fit of the model. The standard error of the estimate reflects the accuracy of the model's predictions, with a value of 0.484. The Change Statistics highlight the significant contribution of the predictors to the model, with an F statistic of 455.076 and a corresponding p-value of 0.000, indicating that the model as a whole is statistically significant. Overall, these results underscore the effectiveness of the model in predicting the level of awareness and understanding of ITS among road users in the Minna metropolis, providing valuable insights for policymakers and stakeholders in enhancing ITS awareness initiatives.

Table 3: ANOVA^a

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	427.111	4	106.778	455.076	.000 ^b
Residual	75.788	323	.235		
Total	502.899	327			

In the context of assessing the level of awareness and understanding of Intelligent Transportation Systems (ITS) among road users in Minna metropolis, the ANOVA table provides important information about the overall fit of the regression model. The table indicates that the regression model accounts for a significant amount of variance in ITS awareness, as evidenced by the significant F-statistic of 455.076 ($p < 0.001$). This suggests that the predictors included in the model collectively have a substantial impact on explaining differences in ITS awareness levels among road users. The regression sum of squares (427.111) represents the variation in ITS awareness that is explained by the predictors, while the residual sum of squares (75.788) represents the unexplained variation. Overall, these results support the notion that the regression model is a valuable tool for understanding and predicting the level of awareness and understanding of ITS among road users in the Minna metropolis.

Table 4: Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
1 (Constant)	-.064	.159		-.405	.686	-.377	.248

select the ITS application(s) or technologies you are familiar with							
how often do you use ITS for navigation and gathering/dissemination of traffic information							
What are the potential benefits of ITS for road users							
How would you rate your overall level of ITS understanding							
	-.070	.065	-.072	-1.065	.288	-.198	.059
	.056	.092	.043	.616	.538	-.124	.237
	.272	.067	.300	4.071	.000	.141	.404
	.650	.065	.678	10.059	.000	.523	.777

$$Y = -0.64 + \beta_1 (-0.70) + \beta_2 (0.56) + \beta_3 (0.272) + \beta_3 (0.650) + 0.159$$

The coefficients table in the examination of Intelligent Transportation Systems (ITS) awareness among road users in Minna metropolis offers valuable insights into the influence of various predictors on the regression model. This table delineates the impact of each predictor on the dependent variable, ITS awareness, with the "Unstandardized Coefficients" showcasing the change in ITS awareness for every one-unit alteration in the predictor. Meanwhile, the "Standardized Coefficients" portray alterations in standard deviations of ITS awareness for every standard deviation change in the predictor. Among the predictors, the rating of overall ITS understanding stands out as the most influential, evidenced by its substantial coefficient of 0.650, signifying a direct correlation between increased understanding and heightened awareness of ITS. This predictor's prominence is further underscored by its notably high standardized coefficient of 0.678, indicating its predominant role in elucidating variations in ITS awareness levels.

Furthermore, the predictor gauging the perceived benefits of ITS for road users emerges as another significant contributor to ITS awareness, denoted by its positive coefficient of 0.272 and standardized coefficient of 0.300. These figures illustrate a tangible association between positive perceptions of ITS advantages and enhanced levels of awareness among road users. In contrast, predictors about the familiarity with ITS applications or technologies and the frequency of ITS usage for navigation and traffic information dissemination demonstrate minimal impact, as evidenced by their smaller coefficients and non-significant p-values. This suggests a limited influence of these factors on the overall levels of ITS awareness within the Minna metropolis context, highlighting the preeminent roles of understanding and perceived benefits in shaping road users' awareness and comprehension of ITS.

5.0 Conclusion

The analysis reveals that the level of awareness of ITS among road users in Minna Metropolis is relatively low, with significant variations across different demographic groups. Education level appears to be a critical factor influencing awareness. The perceived benefits of ITS are well recognized, particularly in terms of improving traffic flow and safety. However, several barriers, including lack of information, technological challenges, and infrastructure limitations, hinder ITS adoption. The study concludes that while awareness of ITS in Minna Metropolis is currently low, there is a clear recognition of its potential benefits among road users. Addressing the identified challenges through targeted awareness campaigns, stakeholder engagement, infrastructure development, policy support, and training programs can significantly enhance ITS adoption. This will lead to more efficient and safer transportation systems in Minna Metropolis, benefiting all road users.

6.0 Recommendations

Based on the findings from the assessment of the level of awareness of Intelligent Transportation Systems (ITS) among road users in Minna Metropolis, the following recommendations are proposed to enhance ITS awareness and adoption:

1. The awareness campaign should focus on younger and less educated populations who demonstrated a low level of awareness;

2. Various platforms including social media, local radio, television, and community workshops can be used to reach a broad audience;
3. Organize regular community workshops and seminars to educate the public on ITS;
4. Introduce ITS awareness programs in schools and universities to educate the younger generation;
5. Conduct regular training programs for drivers and public transport operators to improve their understanding and use of ITS; and
6. Conduct regular surveys and studies to assess the level of ITS awareness and adoption among road users.

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**TANNERY WASTEWATER TREATMENT USING GROUNDNUT SHELL FOR
SUSTAINABLE SMALL- SCALE IRRIGATION IN MAIDUGURI.****¹Abba B. S, ¹Usman, Y.M, ¹Sheriff, B, ¹Hassan S. and ¹Hussaini, M.**¹Department of Agric. and Bio-environmental Engineering Technology, Ramat Polytechnic
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ABSTRACT

Tannery wastewater is composed of a complex mixture of organic and inorganic components from various processes that can critically pollute the environment, especially water bodies if discharged without treatment. An experiment was conducted to assess the Impact of Groundnuts shell powder on Tannery Waste Water Treatment for Small Scale Irrigation in Maiduguri, Borno state. The absorbent material used was raw groundnut shell and carbonated groundnuts shell powder at different dosage (10, 20 and 30g). The following chemical properties of the tannery wastewater was considered; chromium, potassium, calcium, magnesium and sodium. The blank sample has concentration of chemical range between 2.54 to 285.48ppm/l. The concentrations of ion in the samples was drastically decrease to between 1.87 to 189.52, 0.68 to 181.25 and 0.44 to 169 .30 ppm/l after 10, 20 and 30g of the raw groundnut shell were added respectively. Irrespective of the adsorbent dosage the ionic concentration in all the treatment were above FAO standard limit for Irrigation except chromium (Cr). The same dosage of the carbonated material was added, the concentration of ion in the sample decreases to 1.03 to 146. 41, 0.43 to 135.18 and 0.22 to 124.30 ppm/l. The result indicates at 30g of the carbonated dosage the ionic concentration in all the sample were within FAO standard limit for irrigation. The results indicates that the carbonated groundnut shell powder used in this study can be apply as suitable adsorbent material for the treatment of tannery wastewater for small scale irrigation.

Key word: Tannery effluent, Groundnut shell, Irrigation, Carbonated, Concentration**1.0 INTRODUCTION**

Sustainable management of water resources for Agricultural production has become a critical concern, particularly in regions where water scarcity poses significant challenges like Maiduguri. The ever increase in human population and industrialization growth has led to increase in demand of water resources for agricultural purposes. This has cause relentless pressure and scarcity on the water resources in an effort to meet food requirement for the growing human population. It has been predicted that by 2050, the current world population of 7.3 billion will increase to over 9 billion people with special reference to developing countries of the world and about 70% increase in the present agricultural productivity will be needed to meet the food required for the predicted population growth (Zaman et al, 2018).

Tannery wastewater, characterized by its high chemical and heavy metal concentrations, is one of the most problematic industrial effluents. The discharge of untreated tannery wastewater not only jeopardizes the environment but also poses health risks to the surrounding communities. Rigueto, (2020) points to an array of chemicals that are used, including: calcium hydroxide, sodium chloride, sodium sulphide, acids, carbonates and sulphates, particularly chromium sulfate. Kokkinos and Zouboulis (2020) point to hazards throughout the production process. Without proper treatment, negative effects can be borne through three basic methods: gaseous emissions, wastewater, and solid waste. Addressing this issues is essential for both environmental protection and the sustainable use of water resources. Tanneries generate wastewater that contains a complex mixture of various chemicals used in leather processing. This wastewater also contains a significant load of pollutants, including chromium, which is a highly toxic heavy metal. Treating tannery wastewater effectively is crucial to prevent its detrimental effects on ecosystems and human health. Moreover, the treated wastewater can be repurposed for irrigation, offering a sustainable solution for water use in agriculture. In recent years, researchers and environmental engineers have been exploring various treatment technologies to treat tannery wastewater efficiently and cost-effectively such as membrane processes (Suthanthararajan, et.al, 2004), advanced oxidation processes (Sauer, et. Al, 2005), coagulation and flocculation (Haydar, et. al, 2009), electrochemical treatment (Costa, et. al, 2008 and Szyrkowicz, et. al, 2005), aerobic and anaerobic processes (Goswami, et. al, 2013). One promising approach involves the use of adsorbent materials to remove chemical pollutants and heavy metals from the wastewater. Groundnut shells, an agricultural waste product, have emerged as a potential candidate for this purpose due to their low cost, abundance, and natural adsorption properties. Groundnut shells contain lignocellulosic fibers and bioactive compounds, making them an attractive choice for wastewater treatment applications.

This study aim to investigate the influence of groundnut shell-based adsorbents on the treatment of tannery wastewater, with a specific focus on their potential to remove chemical and heavy metals. By harnessing the natural adsorption properties of groundnut shells, we seek to provide insights into a sustainable and eco-friendly approach to wastewater treatment in the tannery industry. Additionally, we shall explore the feasibility of using the treated

wastewater for irrigation, promoting water recycling and reducing the burden on already scarce freshwater resources. Understanding the impact of groundnut shell-based treatment methods on tannery wastewater can significantly contribute to the development of more environmentally responsible and economically viable practices in the leather industry. This research offers an opportunity to bridge the gap between wastewater treatment and agricultural sustainability, demonstrating the potential for a circular and eco-conscious approach to water resource management.

2.0 MATERIAL AND METHODS

2.1 Collection of Sample

Tannery effluent of about 10 liters was collected at the Lawan Bukar, Maiduguri, Borno State tannery site, transported and was preserved in a refrigerator to avoid further microbial contamination.

The adsorbent material used was groundnuts shell. About 10kg of the groundnut shell was bought from the Maiduguri cattle market. The adsorbent material was divided into two; one part was grounded raw in to powdered form while the other part was oven dried for about 12hrs at 105⁰ c before grounded and sieved as shown in plate 1 and plate 2. The adsorbent material (carbonated and raw groundnut shell powder) used for the research was 10g, 20g and 30g.



Plate 1: Carbonated groundnut shell



Plate 2: Raw groundnut shell

2.2 Preparation of Sample

The tannery effluent was filtered using a clean clothing material to reduced larger particles size. Then about 0.5 liter of the filtered tannery effluent was measured in to seven clean plastic bottles. The adsorbent material (carbonated and raw) of 10, 20 and 30kg was then added to the tannery effluent in the bottles. Each sample was mixed thoroughly in a blender for about ten minutes. The blended sample were kept for one (1) hour to settle. The mixture was then filtered and finally, 100ml of the sample were collected for laboratory analysis.

2.3 Chemical Analysis

The chemical analysis of the sample such as potassium (k), calcium (Ca), magnesium (Mg), Sodium (Na) and Chromium (Cr) were carried out at Science Laboratory Technology chemistry Laboratory, Ramat Polytechnic Maiduguri using Ultra Violet Spectro-Flame Photometer.

2.4 Data Analysis

The data analyses of the result obtained were performed using Microsoft Excel 2013.

3.0 RESULT AND DISCUSSION

3.1 Influence of Absorbent Materials on the Tannery Wastewater

3.1.1 Effect of groundnut shell powder on Tannery effluent

The result in Fig. 3.1 indicates the influence of different dosage of groundnut shell powder on chemical properties of tannery waste water. The blank sample indicates high concentration of chemical range between 2.54 to 285.48ppm/l. The concentrations of the chemical in the samples was drastically decrease to between 1.87 to 189.52 ppm/l after 10g of the adsorbent material was added. Further decrease in the concentration of the chemicals range between 0.68 to 181.25 ppm/l in the sample was observed after 20g of the adsorbent material was added. The treatment with 30g of the adsorbent material further decreases the chemical concentration to 0.44 to 169.30 ppm/l. It was observed that irrespective of the adsorbent material dosage the chemical concentration in all the treatment were above the FAO standard limit except calcium (Ca) and chromium (Cr). The rapid increase in the removal efficiency of chromium as the amount of the adsorbent dose increases is due to the availability of more adsorption material and greater availability of the surface area at a higher concentration of the adsorbent (Mohanty et al. 2005).

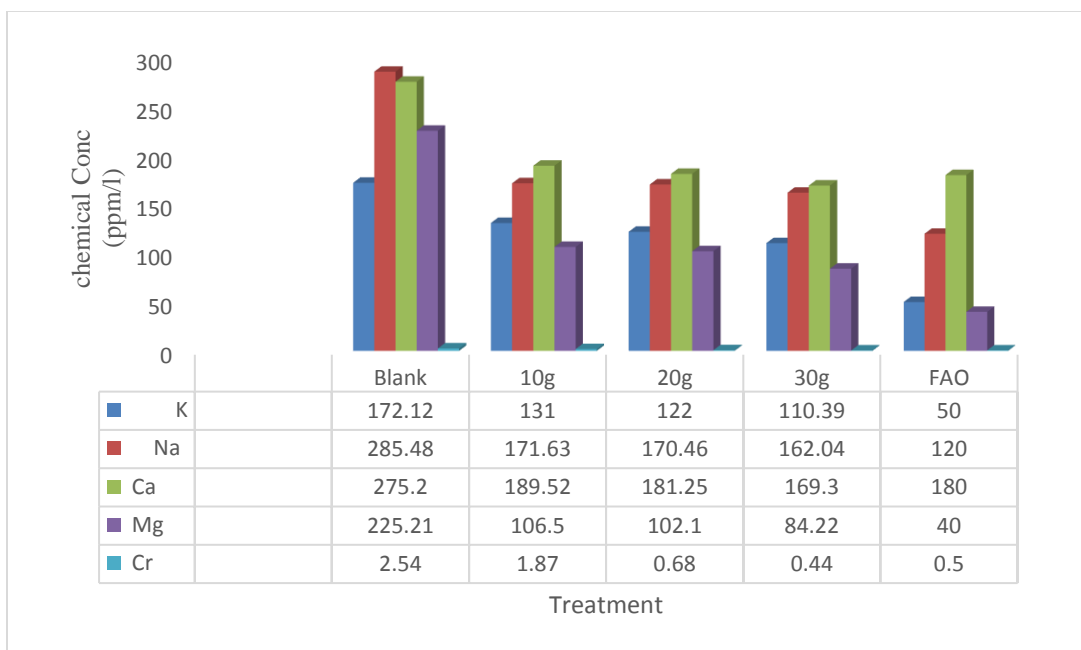
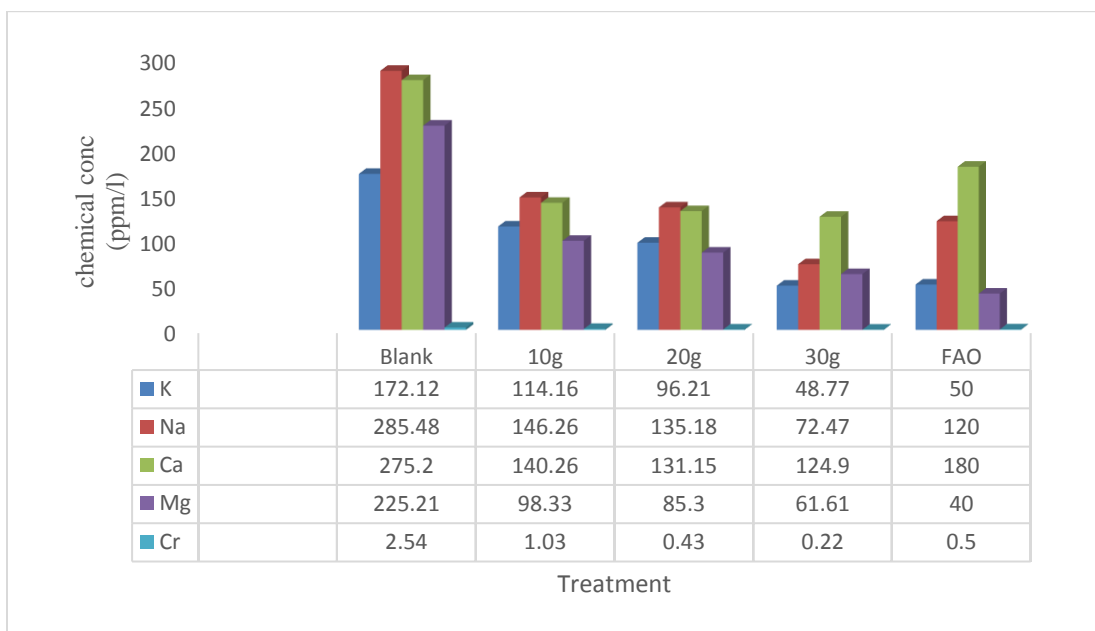


Fig. 3.1 Effect of groundnut shell powder on chemical properties of Tannery effluent**3.1.2 Effect of Carbonated Groundnut Shell Powder on Tannery Effluent**

The effect of carbonated adsorbent material on the chemical properties of tannery effluent is presented in Fig 3.2. The result indicates that there is high decrease in the concentration of chemical in the samples. The blank samples has chemical concentration range between 2.54 to 285.48 ppm/l. When 10g of the adsorbent material was added the concentration of the chemical decreases to 1.03 to 146.26 ppm/l. Further decrease range from 0.43 to 135.18ppm/l was observed after 20g of the carbonated adsorbent material was added. Finally, the chemical concentration of the tannery effluent decreases to about 0.22 to 124.90 ppm/l after 30g of the carbonated adsorbent materials was added. It was observed from the research that increase in the adsorbent dosage is directly proportional to the decrease in the concentration of chemical in the tannery effluent. Thus, it indicates that at 30g adsorbent dosage the concentration of chemicals in all the samples were within the FAO standard limit for irrigation except magnesium (Mg).

**Fig. 3.2 Effect of carbonated groundnut shell powder on chemical properties of Tannery effluent**

4.0 CONCLUSION

It is an evident from the research that tannery effluent from the tannery industry contains a high concentration of various chemicals that exceed the established regulatory limits. This makes untreated tannery effluent into surface water a significant threat to the environment and human health. The groundnut shells used in this study exhibited high potentiality for the removal of high concentration of chemical ion from aqueous solution. It indicates that there was high chemical concentration of Na, Ca, Mg, K and Cr range between 2.54 to 285.48 ppm/l in the blank sample. When 10g, 20g and 30g of the raw groundnut shell powder was added to the tannery effluent. The concentration of chemical in the sample decreases to 0.44 to 169.30 ppm/l but is above the FAO irrigation water standard. While 10g, 20g and 30g of carbonated groundnut shell powder was added to the blank sample. The concentration of the chemicals in the sample was decrease to 0.22 to 124.90 ppm/l. Which shows most of the chemical concentration decrease to a level within FAO irrigation water standard limits except magnesium (Mg). It can be conclude from the research that carbonated groundnut shell powder can be effectively used in treating tannery waste water for Irrigation.

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IMPACT AND UTILIZATION OF ELECTRICAL AND ELECTRONIC ENGINEERING IN INNOVATIVE TECHNOLOGY FOR SOCIO-ECONOMIC AND NATIONAL DEVELOPMENT

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ABSTRACT

Innovative technology is very vital to the achievement of national development. So, it needs to be given special consideration for the nation's well-being. Electrical and electronic engineering can be employed as a tool to boost the nation's socio-economic growth by enabling its citizens to engage in entrepreneurship and the acquisition of education. This paper intends to present the utilisation of electrical and electronic engineering through innovative technology in empowering Nigerians for national development as well as the impact of electrical and electronic engineering in human development. The application of electrical and electronic engineering in empowering Nigerian youths through entrepreneurship and the use of electrical and electronic engineering in empowering Nigerians through education were addressed in the paper. Innovations and future challenges in electrical and electronics engineering were also discussed. Recommendations made in the paper pointed out drastic measures and efforts to be considered to encourage and propel the use of electrical and electronic engineering in empowering Nigerian youths and curtail the menace of social vices, rampant kidnappings and ethnic crises among citizens. The paper also highlighted that electrical and electronic engineering can enable the citizens of the country to be empowered for job creation and income generation, as well as for intellectual enhancement and self-reliance for sustainable national development.

Keywords: Impact and Utilization, Electrical and Electronic, Innovative Technology, Socio-Economic Development

Introduction

Innovation is an essential process of change that is necessary to maintain the development and growth of an enterprise. Innovation is defined as the ability of an enterprise to “manage knowledge creatively in response to market-articulated demand and/or other social needs”. Innovation plays a pivotal role in economic progress by increasing enterprise competitiveness in the global marketplace. New scientific and technological advances have created evolutions in innovation processes, and technology is a primary enabler of

innovations in enterprises. While market demand orients the market, it requires the integration of research with manufacturing, technology with production, and both research and technology with customers and suppliers. One very critical challenge Nigeria has faced for over three decades now is how to bring development to the grassroots, and hence better the lot of the citizenry. An important key to this problem lies in recognizing the need for technological growth and development. Explicitly, development, seen from adequate provision of electric power (Maduewesi, 2005), is untenable without undertaking functional education. The more functional education which can lead Nigeria out of the economic doldrums is technical and vocational education (TVE). One of the components of TVE is electrical and electronic technology. Patzhiko and Abdulsalam (2012) related that electrical and electronic technology education is begun at the technical colleges today. In essence, electrical and electronic technology education is today offered in polytechnics, colleges of education and universities. The aim is to acquaint individuals with knowledge, skills and attitudes that make them functional members of the world of work, thereby contributing to nation-building. The indices of any developed society are energy supply, transportation system and communication system. Buttressing this point, Inyama (2014) argued that "The reliability, quality and quantity of electricity consumed annually of every nation are an index of socio-economic development".

Utilization of Electrical and Electronic Engineering in Empowering Youths for Socio-economic Development

Entrepreneurship deals with the ability to set up a business enterprise as different from being employed (Osuwa, 2015). Entrepreneurship creates employment opportunities in that an entrepreneur can establish a business and employ people for jobs in the business and pay them. There is a need to emphasize entrepreneurship (job-creation) in Nigeria because one situation that threatens national development in Nigeria is unemployment. Nwosu (2005) pointed out that employment helps to generate income for a happy and healthy life as well as for the prevention of idleness that is associated with social vices, which inhibit socio-economic development. Unfortunately, a lot of youths in Nigeria are unemployed and so are prone to get involved in immoral activities associated with national insecurity such as

stealing, murder, duping, kidnapping, etc that negatively affect national development. Therefore, the involvement of the youths in various self-employed activities further promotes self-reliance and the generation of income. There are job opportunities which the knowledge of electrical and electronic engineering can provide for the youths. Electrical and electronic engineering makes it possible for the youths to become intellectually equipped in the area of electronic instrumentation and control, computer technology, telecommunications, robotics, coil rewinding technology, installation technology, repairs of electrical and electronic components and engineering management. With the knowledge and skills in electronic engineering, the youths can be empowered to be entrepreneurs working as operators of electronic-based systems, computer programmers, electronic engineers, electronic engineering lecturers, consultants in electronic-based activities, vendors of electronic products, or managers in electronic-based organizations. It should be recalled that engaging in jobs provides income for comfortable living and prevention of idleness that can lead to social vices which jeopardize socio-economic and sustainable development. Electronic engineering knowledge and skills are employed in the production of computers. Computers make our daily work easier and faster. So, computers can serve as vital electronic machines for the enhancement of the operations of the youths who are entrepreneurs. Computer systems have important features that make them serve as useful electronic devices in entrepreneurship: they operate at a fast speed and give accurate results; they are reliable because they can operate for many hours; because computers can be reprogrammed, they are flexible and adaptable to various operations; and computers turn out neat products. There is no doubt that computers enhance productivity. Geraldine (2020) asserted that the purpose of computer systems is to speed up problem-solving and increase productivity. Knowledge and skills obtained from electronic engineering have made the existence of Information Technology (associated with communications) possible. It is known that the major purpose of communication is to transmit information. Information enables meaningful interactions in any human activity and so, information is needed to achieve effective and efficient entrepreneurship. The use of electronic systems and devices like phones (handsets), computers, memory cards, CD-ROMs, etc., can empower the youths to store and communicate information that can boost entrepreneurship. In this modern era, the Internet

has made the world a global village. The knowledge and skills of electrical and electronic engineering would bring about innovative ways in which the Internet can be used. With the Internet, the youths can communicate with people from any part of the world to enhance productivity, using facilities like electronic mail (e-mail), WhatsApp, Facebook, X (formerly Twitter), Instagram, YouTube and many more. All these provide a fast and economically convenient means of sending and receiving messages around the world. Also, the Internet makes it possible to have electronic business activities such as E-commerce, E-banking, E-conferencing, etc which the youths can use to enhance their entrepreneurship. Fortunately, electrical and electronic engineering provides avenues for intellectual enhancement through exposure to the use of computer and software applications. Knowledge and skills in electrical and electronic engineering have helped in the production of electronic devices/systems such as radio, television, phone, and video machines. Such electronic products can be used to empower the youths for entrepreneurship. For example, entrepreneurial knowledge and products can be broadcast on radio and television to expose youths to real-life job creation and management scenarios. Also, practical entrepreneurial activity can be videotaped and watched on a video machine for a clearer and deeper understanding of entrepreneurship practices.

Impact of Electrical and Electronic Engineering on Socio-economic Development

Engineering is a discipline or activity between science and technology, for it deals with the use of scientific principles in designing and producing materials and devices that make a man feel more comfortable in his environment (Nwosu, 2010). Idowu (1992) asserted that engineering is a profession in which knowledge of mathematical and natural science gained by study, experience and practice is applied with judgment to develop ways to utilize economically the materials and forces of nature for the benefit of mankind. One of the prominent fields of engineering is electrical and electronic engineering; and it deals with the conduction of electricity (charges) through conductors (metals), semi-conductor materials or valves (vacuum and gas-filled devices). Semiconductor materials and devices are principally used in modern electronic engineering, and electronic engineering is concerned with solid-state systems, computers, and telecommunication. On the other hand, electrical engineering

deals with generating, transmitting and distributing electrical power; and electromagnetic/electromechanical devices such as transformers, electric generators, and motors. Another aspect of both electrical and electronic engineering is instrumentation and control. It can be said that electrical and electronic engineering is the use of the science of electricity to design systems for the technological well-being of man in his environment. Man experiences some pleasure and comfort in his environment due to electrical and electronic engineering products such as electric motors, generators, lamps, refrigerators, air-conditioners, electric cookers, radios, televisions, computers, telephones, video machines, calculators, and audio amplifiers. In this modern era, electrical and electronic engineering has brought certain revolutions in human activities especially due to the presence of electronics that have brought about the emergence of information technology. As rightly noted by Inyama (2014), electronic technology has brought about changes in communication and the important development in electronic communication has impacted the way business, administration, education and government are conducted in the emerging world of the third millennium. Electrical and electronic engineering can play a role in national development by positively influencing the lives and activities of the youth. One of the roles of engineering in the life of the youths, for national development, is the promotion of entrepreneurship.

Electrical engineering has played a vital role in shaping the world we live in today. From powering our homes and businesses to the invention of electronic devices, Electrical and electronic engineering has been a crucial factor in shaping our modern lifestyle through the following.

- 1 **Power Generation and Distribution:** Electricity is a staple item in our lives. Without it, modern life would come to a complete halt. Electrical engineers are responsible for designing and developing power grid systems that can distribute electricity from power plants to homes and businesses.
- 2 **Lighting and Illumination:** From traditional incandescent bulbs to modern LED lights, electrical engineers have been innovating lighting technology for decades. The advancements in lighting technology have transformed the way we light up our homes, workplaces, and streets.

- 3 **Electronic Devices:** Starting with radios and televisions and moving on to computers and smartphones, electronic devices revolutionized the world. Electrical engineers have had a significant role to play in the development of these devices, from designing the circuit boards to developing the software that powers them.
- 4 **Transportation:** Electrical engineers have been integral in designing and developing the technology needed to create modern transportation systems, including electric cars, trains, and planes. They have also been instrumental in developing the infrastructure and power systems needed to support these transportation systems.

Role of Electrical and Electronic Technology Education in National Development

General and electrical and electronic technology education play several roles in national development. These roles can be identified as follows:

1) Production of Skilled Manpower: - Nigeria today has many skilled electrical and electronic personnel who work both in teaching service and industry. In our universities, technical colleges, polytechnics and other tertiary institutions, many electrical and electronic engineering teachers are very skilled (Danaan, 2016). Though this number is inadequate given the growing expansion, Nigeria has a well-trained technological manpower capable of managing various aspects of development. In the power sector, Nigeria has skilled personnel to handle power generation, transmission and distribution as well as telecommunication problems. Today, Nigeria occupies a prominent place in the comity of nations 'because, just like South Korea, the outstanding resource is the preference for scholars and this forms the basis for achieving fame, wealth and power.

2) Acquisition of Economic Power: -Donou-Adonsou (2019) rightly observed that electric power is the lifeblood of physical and material development for any nation. Consequently, the acquisition of electrical and electronic technology education by a developing country like Nigeria entails to a large extent economic power. Had it not been for the many problems recorded in the power sector for decades now which have impeded economic growth, Nigeria would have generated enough revenue from that sector to make her economically vibrant. All these problems, however, can be dealt with given the correct attitude of mind regarding maintenance and leadership.

3) Improvement in Living Standards: - Electric power supply remains the most important resource for any developing nation. This is so because industrial activities depend to a large extent upon its availability. Electrical and electronic technology education, therefore, will ensure the strength of Nigerian industries and the living standard of the Nigerian people. It must be made explicit here that electrical and electronic education and the availability of electric power and electronic gadgets will undoubtedly better living conditions in areas like heating, cooling, lighting and electronic TV/Video entertainment. The availability of electric power, coupled with useful electronic education has led many homes to have their personal computers (PCs) for indoor use.

4) Complementing the Effort of Government in Power Generation, Transmission and Distribution: - The process of electric power generation, transmission and distribution is not only a capital-intensive enterprise but it is also a complex arrangement that requires a lot of skills and expertise. Because of cost implications and problems relating to management and societal attitude to basic infrastructure, constant power supply in Nigeria has been a mirage, despite the government's large spending in the sector. To complement the government's effort, electrical and electronic technology education, acquired in school, has led well-meaning Nigerians to design, construct and install their power systems in partnership with their foreign friends. The rise of Independent Power Producers (IPP) came about out of necessity. When the government saw the need for the private sector to be involved in power generation, transmission and distribution, the following private electric power companies, among others, came on board: Eleme Gas Turbine Power Plant, Siemens Nigeria Lt, and Abuja Captive Power Plants. But for the effort of these private companies, one would expect nothing from distribution companies (DisCos) save a sorry condition. In other words, the effort of IPP is commendable in complementing DisCos by generating, transmitting and distributing electric power to Nigerian industrialists and other users

5) Electrical and Electronic Technology Education in Manufacturing Activities: -A nation's development is viewed in terms of manufacturing activities that go on in its industries and the number of goods turned out". Manufacturing is, however, impossible without the skills and knowledge that electrical and electronic technology education

provides. The lifeblood of any manufacturing industry is electric power. Machine tools, electrical and electronic appliances, systems industries, and many others depend greatly on electric power supply. Electrical and electronic technology education and skill training are, therefore, indispensable in the production of goods and services.

6) Employment Generation: - One of the problems besetting successive governments in Nigeria is unemployment. Electrical/electronic technology education is therefore a viable option to deal with unemployment. To achieve this, entrepreneurship in electrical and electronics may be necessary. Consequently, there is today a growing number of employed people in electrical and electronics who passed through one form of training or the other. There are self-employed people doing generator and motor repair work, radio and electronic repairs and television services. Although, as roadside mechanics, they have been relevant and in high demand to resuscitate electrical and electronic systems. Quite a number of them engage in the manufacture of electrical and electronic systems and spare parts. Now all these people are not only reducing the menace of unemployment but they are also contributing to revamping the national economy.

Innovations in Electrical and Electronic Engineering

In the modern world today, many innovations in electrical, electronics and communication engineering have revolutionized various industries and transformed how we interact with technology. From the Internet of Things to 5G communication, AI, flexible electronics, and blockchain technology, these advancements offer numerous benefits and opportunities for individuals and businesses. Embracing these technologies will pave the way for a more connected and efficient future.

Internet of Things (IoT):-The IoT has revolutionized various industries by enabling seamless connectivity between devices. It refers to the network of interconnected physical objects, such as appliances, vehicles, and wearable devices, embedded with sensors and software. The ability to collect and exchange data in real time has led to improved efficiency, automation, and convenience in our lives. The advantages of IoT are improved efficiency and productivity, enhanced safety and security, cost savings through automation and real-time data for better decision-making.

5G Communication: -5G technology is the latest generation of wireless communication, promising faster speeds, reduced latency, and increased connectivity. It is expected to support a wide range of applications, including autonomous vehicles, smart cities, and immersive virtual reality experiences. Key features of 5G include higher data rates for faster downloads and uploads, lower latency for real-time communication, increased network capacity to handle more devices simultaneously and improved reliability and energy efficiency.

Artificial Intelligence (AI): -AI is transforming the electronics and communication engineering domain by enabling machines to mimic human intelligence. This technology has various applications, including image and speech recognition, natural language processing, and predictive analytics. Key takeaways from AI include improved automation and efficiency, enhanced decision-making based on data analysis, personalized user experiences, and reduced human error in complex tasks.

Flexible Electronics: -Flexible electronics, also known as bendable or wearable electronics, are gaining popularity due to their ability to conform to various shapes and sizes. These electronics are made from flexible substrates, such as plastic or thin metal, enabling innovative product designs and applications. The advantages of flexible electronics are lightweight and portability, improved durability and resistance to damage, convenience and comfort for wearable devices and cost-effective production.

Blockchain Technology: -Blockchain technology, initially popularized by cryptocurrencies, has extended its applications to various industries, including electronics and communication engineering. Blockchain enables secure and transparent transactions, data sharing, and decentralized systems. Key features of blockchain technology include security and privacy through encryption, decentralization and elimination of intermediaries, traceability and immutability of data and efficient and streamlined processes.

Smart Grids and Sustainable Energy: - Smart grids represent a paradigm shift in energy generation, distribution, and consumption. Smart grids improve efficiency, reduce losses, and seamlessly incorporate renewable energy sources by using modern sensors, communication networks, and data analytics. Electrical engineers specialized in grid modernization and

sustainable energy solutions are critical to guarantee a stable and environmentally friendly power supply in the future.

Advancements in Communication Technology: -In the early 1900s, electrical Engineer Guglielmo Marconi invented the first practical device for wireless communication (Nwosu, 2013). It was called the radio, and it paved the way for the even more incredible invention of television. Now, almost 100 years later, we have smartphones that can access large amounts of information and transmit high-quality video in mere seconds. The advantages of communication technology involve staying connected with the world through social media, accessing a wealth of information anytime, anywhere, communicating with others instantly and effortlessly, etc. As communication technology continues to advance and become more compact, the level of influence it has on our lives and society will only continue to grow.

Automation and Robotics: -Electrical engineering has driven major advancements in industrial automation and robotics. Automated systems can increase efficiency, safety, and productivity in industries such as manufacturing, transportation, and agriculture. Robots can perform tasks that are too dangerous, tedious, or time-consuming for humans to undertake, freeing up human labour for more cerebral occupations. Major Key features of automation and robotics are an increase in efficiency and productivity in industries such as manufacturing and agriculture, a reduction in workplace injuries by taking human workers out of unsafe or dangerous environments, improved quality of goods and services due to increased precision and creation of new jobs designing, programming, and maintaining automated systems and robots. As these technologies continue to evolve, they will undoubtedly have a greater impact on our lives and industries worldwide.

Future Challenges in Electrical and Electronic Engineering for Socio-economic Development

Electrical engineering is at the forefront of innovation. From smart grid technology to advancements in lighting and lighting control systems, electrical engineers work diligently to enhance our everyday lives and move communities forward. Electrical engineering is the study, design, and application of equipment, devices, and systems that use electricity, electronics, and electromagnetism. This discipline emerged as an occupation in the late 1800s

with the invention of the electrical telegraph, which introduced a way to transmit information without physical transportation. Electrical engineers enjoy collaborative projects, rewarding work, and competitive earnings. However, this type of job comes with its share of challenges.

1. Continuing Education: -High-quality work calls for high-quality workers. Electrical engineers are expected to be expert analysts and problem-solvers, in conjunction with staying on top (and ahead of) the latest industry trends. Therefore, electrical engineering is a profession that demands continuous education—something that isn't always easy when you work a full-time job and have ongoing projects. There are many online resources for electrical engineers seeking continuing education and certificate programs. Additionally, your place of work may have on-site training. For this reason, it's important to keep up with company updates and events. For example, some agencies and companies try to ease some of this burden by having their training paradigm for employees who want to learn valuable skills and earn new certifications.

2. Stress Management: -When it comes to the world of electrical engineering, there are a lot of moving pieces. Electrical engineers have got to manage a million different things and navigate spontaneous challenges. And as a nationwide hiring shortage persists, electrical engineers among other professionals are asked to do more with less. This “do more with less” mentality coupled with the fact that electrical engineers typically work on multiple projects at one time, can result in a stressful work environment. Rapid developments in technology put pressure to decrease time-to-market measures. Engineers are forced to either keep up or step down. While this type of career is best suited for people who thrive in fast-paced environments, frustration happens to everyone. Maintaining regular communication and a positive work culture are critical. Set your health as a priority and know when it's time to take a break to help manage your stress.

3. Price and Performance: -Delivering projects on time and within budget is the ultimate goal of every job. A simple yet weighty promise, a lot that goes into making it happen. Electrical engineers are responsible for ensuring compliance with specifications, codes, and customer requirements, and estimating costs and most contractors will expect quality materials at a low cost. Because electrical engineers are critical thinkers by trade and

want to give clients the most bang for their buck, they know that there are ways to maximize efficiency and save money without cutting corners. This requires implementing techniques such as agile construction methods, Building Information Modeling (BIM), and prefabrication.

4. Powered by Safety: -From electrical shocks to falls, explosions, and more, the electrical engineering industry is no stranger to danger. The leading causes of industry-related injuries occur when a worker has contact with high-voltage electrical lines and falls. Being aware of your surroundings and having safety integrated into operations is critical to maintaining a safe work environment. Prefabrication is an excellent way to enhance safety for all team members, as it reduces time spent on the actual job site.

5. Evolving Industry: -People are more conscientious than ever about creating environmentally friendly developments. Electrical engineers have become vital resources in helping organizations establish sustainable practices. This increasingly important facet of their job adds duties such as maintaining and updating generators, setting up substations for circuit breaking, predicting future power needs, and more to an already full plate of responsibilities. Smart grids have become key players in collecting data about transmission and distribution and enhancing sustainability. For remote areas not connected to the grid, renewable energy hybrid power systems can increase access to cleaner electricity. Electrical engineers have become as essential to modern life as the buildings wherein we live and work. It's a lucrative and rewarding career; that is, if you're up to the challenge.

As we look to the future, the role of electrical engineering in shaping our technological advancements will only continue to grow. Some of the key areas where electrical engineering is poised to make a significant impact in the coming years include:

- **Artificial Intelligence** - Electrical engineers are at the forefront of developing AI technologies that will transform the way we live and work.
- **Quantum Computing** - Electrical engineers are working to develop the next generation of computing technologies, including quantum computers that will have the power to solve some of the world's toughest problems.

- **Smart Cities** - Electrical engineers are designing and developing the infrastructure required for smart cities, which will be equipped with advanced sensors and IoT devices to improve efficiency and quality of life.

Conclusion

The youths as one of the stakeholders in ensuring national development need to be empowered. There is a need for youth empowerment to overcome unemployment existing in Nigeria. Also, for the youths to contribute effectively towards national development they need to be empowered through education. However, electrical and electronic engineering can be employed in youth empowerment for national development in Nigeria. Application of electrical and electronic engineering will help the youths engage in entrepreneurship that is useful in job creation and income generation. Electrical and electronic engineering can enable the youth to be empowered through education for intellectual enhancement and self-reliance for sustainable development in the nation.

Recommendations

To encourage the utilisation of electrical and electronic engineering in youth empowerment for national development it is recommended that:

1. Nigerian youths should have a focus and positive attitude towards the use of electrical and electronic engineering in entrepreneurship and education.
2. Youths studying electrical and electronic engineering and related courses should be hard-working and apply the education acquired in national development.
3. The government should help in the provision of facilities and resources for fostering studies and activities in electrical and electronic engineering.
4. Stakeholders (e.g. lecturers, engineers, vendors) concerned with electrical and electronic engineering should embrace ethics and diligence in their job.
5. The mass media should help to enlighten people on the role of electrical and electronic engineering in youth empowerment.

6. Families, organizations and the general public should give support in the utilization of electrical and electronic engineering in youth empowerment.

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WORK ENGAGEMENT AND EMPLOYEES' PERFORMANCE AMONG REGISTERED BAKERIES IN SULEJA EMIRATE, NIGER STATE, NIGERIA.A CONCEPTUAL REVIEW.

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ABSTRACT

Work engagement is one of the important components in the bakery's subsector in the Nigerian economy, which can be embarked upon by people with capital and interest in the sector. Despite these assertions, Challenges persist in the bakery sector of Suleja Emirate. Hence, the paper adopts a conceptual review from reputable data base that examined different dimensions of work engagement in relations to employee's performance of bakeries in Suleja Emirate with a view to have synthesis of commentaries on the concept and theory from existing literature. The major gap of the review was identified in order to justify the need for further studies. The study was premised on work engagement theory of Kahn. A conceptual framework that outline the relationship between variables in the review created. The findings of this study provide recent update on dimension of work engagement as it positively influences employee's performance among registered bakeries in Suleja Emirate. The paper recommend that organizations take a holistic approach to fostering work engagement and enhancing employees' performance, create a supportive work environment that fosters engagement by providing opportunities for autonomy, mastery, and meaningful work.

Keywords: Work Engagement, Employees Performance, Bakeries, Work Engagement Theory.

1.0 Introduction

A common saying in business posits that "customers will never love a company until the employees love it first" (Cesário and Chambel, 2017). This implies that customer loyalty is contingent on the satisfaction derived from the services provided by employees (Kim *et al.*, (2019). The success of any organization relies on the respectful treatment of employees by their employers, reflecting a strong work ethic and effective customer service delivery (Tian *et al.*, 2019).

Furthermore, employees serve as the driving force behind activities aimed at achieving the desired objectives of the bakery sector (Rana *et al.*, 2019). According to Lee and Ok, (2016) affirm that customer satisfaction can only be achieved if employees perform their tasks effectively, benefiting both themselves and their organizations. Additionally, employee performance is a critical aspect to be considered in the service industry, as the overall success of the bakery industry hinges on the competence of its workforce (Fletcher, 2016).

Moreover, for the bakery industry to thrive in the globally competitive market environment, effective working engagements are paramount to influence, direct, and motivate employees to put in their best in service delivery (Breevaart *et al.*, 2016). Effective work engagement improves employee productivity by motivating and convincing them to fulfill tasks efficiently in the bakery industry (Karatepe and Olugbade, 2016).

According Sopia *et al.* (2020) proposed that good work engagement is a major determinant of employee happiness, especially in the Nigerian bakery industry. Knight *et al.* (2017) postulated that work engagement influences employees to strive willingly and enthusiastically toward achieving organizational objectives. Shimazu *et al.* (2015) submitted that work engagement inspires and influences employees to maintain cooperation among them and achieve organizational missions and visions. Hanaysha (2016) affirmed that work engagement can influence employees to achieve a common goal. An effective work engagement should have the ability to foster good interpersonal relations with employees and motivate them to achieve a common goal (Bakker and Leiter, 2017). Similarly, effective work engagement brings employees and their efforts together to get work done efficiently in the bakery industry within appropriate time bounds (Hanaysha, 2016).

Despite the crucial roles work engagement plays in transforming the bakery industry to remain relevant in today's dynamic business environment, it also faces the same work engagement deficiencies that plague other industries (Lisbona *et al.* 2018). However, work engagement in the bakery sector can either motivate or discourage employees, leading to an increase or decrease in their level of performance. It is against this backdrop that this paper seeks to investigate the effect of work engagement on employee performance among registered bakeries in SulejaEmirate, Niger State, Nigeria.

2.0 Literature Review

2.1 Work Engagement

Organizational executives prioritize work engagement as a key focus within the business landscape (Guan and Frenkel 2018). Cesário and Chambel (2017) emphasize that engagement hinges on employees' perceptions of their work experience, encompassing their views on the employer, organizational leaders, job roles, and the work environment. Kim *et*

al. (2019) recommend that managers foster employee engagement by acknowledging and leveraging the skills, knowledge, and talents of their staff. Recognizing and utilizing individual strengths, according to the authors, elevates engagement levels, leading to enhanced performance. Fletcher (2016) characterized work engagement as a positive, fulfilling work-related state of mind marked by vigor, dedication, and absorption.

When employees are more engaged in their work, they will find their work to be easier and interesting rather than challenging and will be more committed, robust and absorbed in their jobs (Brhane and Zewdie, 2018). This will lead employees to think in a positive manner and will help them in serving their customers well (Iskamto, 2021). In a study by Kuswati, (2020) it was found that engagement influences in-role behavior, proactive behavior and also organizational citizen behavior. More so, this shows that employees who are engaged will have a broader perspective of their role and will reach out to broader set of activities in their jobs. This implies that, engagement will have a positive effect on how employees perform their duties, including offering superior assistance to customers (Heeet *al.*, 2019).

More so, Job and personal resources emerge as pivotal predictors of work engagement. Job resources, functional in achieving work goals and mitigating job demands, are highlighted by Kartal (2018), while personal resources, reflecting individuals' perceived control over their environment, are emphasized by Ali and Anwar (2021). Work engagement, the optimal balance between job demands and resources, arises when employees effectively manage workload and other demands through feedback, self-efficacy, and social support.

In the current challenging business environment, work engagement stands out as a critical organizational concern, underscoring the core values of the organization and reinforcing overall brand equity (Lisbonaet *al.*, 2018). Engaged and motivated employees aligned with the organization's values, contributing to increased productivity and firm performance in dynamic markets (Yongxinget *al.*, 2017). Highly engaged employees exhibit passion, happiness, and enthusiasm for their work, making them valuable assets for maintaining competitive advantages, adapting to changes, and fostering innovation (Douglas and Roberts, 2020).

However, it is acknowledged that there is no one-size-fits-all approach to work engagement, and its effectiveness depends on the unique work setting (Lisbona *et al.*, 2018). This study conceptualizes work engagement components as vigor, dedication, absorption, and teamwork, contending that adherence to these components promotes effective communication and respect among employees, ultimately enhancing performance and productivity (Alessandri *et al.*, 2015).

2.1.2 Dimension of work engagement

2.1.2.1 Vigor

Vigor can be defined as an employee's energy levels and mental resilience during work tasks (Cortés-Denia *et al.*, 2023). Lopez-Zafra *et al.* (2022) characterized vigor as relating to both the mental and physical well-being of an employee. As a crucial component of work engagement, vigor signifies the positive energy and mental resilience individuals bring to their work, reflecting a sense of being invigorated by the work itself rather than feeling drained or exhausted (Sopiah *et al.*, 2020).

Engaged employees, marked by vigor among other factors, typically experience heightened levels of job satisfaction (Knight *et al.*, 2017). When individuals feel invigorated and enthusiastic about their work, they are more likely to derive satisfaction and fulfillment from their roles. Vigor contributes to cultivating a positive work environment, and enthusiastic and energetic employees can have a ripple effect on their colleagues, fostering a culture of positivity and motivation within the workplace (Shimazu *et al.*, 2015).

Moreover, Organizations and leaders often strive to nurture work engagement, including the dimension of vigor, as it has been associated with various positive outcomes such as higher job performance, job satisfaction, and overall well-being. Strategies to enhance vigor at work may include providing opportunities for skill development, recognition, autonomy, and creating a positive work environment that supports employees' well-being and motivation (Kundi *et al.*, 2022).

Undoubtedly, vigor emerged as a key component of work engagement with positive implications for individual and organizational outcomes (Huang *et al.*, 2018). Fostering a

work environment that promotes vigor can lead to improved performance, satisfaction, and overall well-being for employees, contributing to the success and positive culture of the organization (Sekhar *et al.*, 2018). Therefore, in this paper, vigor is conceptualized as a factor that enhances employee performance, as organizations with employees maintaining high levels of energy and mental resilience during their work are likely to witness improved performance, productivity, and enhanced customer satisfaction.

2.1.2.2 Dedication

Dedication encompasses the act of being committed, devoted, and wholeheartedly invested in a specific task, cause, or goal, reflecting a strong sense of loyalty, enthusiasm, and perseverance (Ruddy, 2017). It signifies a willingness to exert sustained effort, time, and energy to excel in a chosen pursuit or contribute significantly to a particular purpose (Dunlop and Scheepers, 2023).

furthermore, this commitment is evident in various aspects of life, including work, relationships, hobbies, and personal development (Husain *et al.*, 2021). However, Dedication plays a vital role in achieving long-term goals, fostering success, and building strong connections with others. Whether in the professional or personal sphere, dedication is widely recognized as a key factor in realizing meaningful accomplishments (Arora and Adhikari, 2015). Lazauskaite-Zabielskeet *al.* (2018) emphasize dedication as being highly involved in work, reflected through feelings of enthusiasm, challenge, and significance.

However, Breevaart and Bakker (2018) posited that dedicated employees are more focused, motivated, and productive, leading to higher levels of output and efficiency (Gutermann *et al.*, 2017). Individuals dedicated to their work often experience higher job satisfaction, deriving fulfillment and accomplishment from their commitment (Pourbarkhordari *et al.*, 2016). Dedication is linked to a stronger commitment to the organization, reducing turnover and associated costs.

Moreover, dedication is associated with higher quality work, as committed individuals take pride in their tasks, contributing to superior outputs (Luu *et al.*, 2019). It fosters a positive and proactive mindset, encouraging creative problem-solving and innovative contributions to

work. Dedicated employees contribute to a positive work culture, with their enthusiasm being contagious and inspiring others, fostering a collaborative and supportive environment (Tian *et al.*, 2019). Dedicated individuals exhibit adaptability and resilience in the face of challenges, navigating obstacles with a positive and determined attitude (Kim *et al.*, 2019). This trait is often associated with leadership potential, as consistently dedicated individuals are perceived as reliable, trustworthy, and capable of assuming leadership roles (Fletcher, 2016).

In conclusion, dedication is a cornerstone of work engagement, influencing various aspects of individual and organizational performance (Borst *et al.*, 2020). In this study, dedication is conceptualized as a factor fostering employee performance because when employees maintain commitment, devotion, and wholehearted investment in tasks, causes, or goals, it leads to increased job satisfaction, improved productivity, and a positive workplace culture, ultimately contributing to overall success and well-being. Organizations that encourage and recognize dedication are likely to experience higher levels of employee engagement and sustained success (Kartal, 2018).

2.1.2.3 Absorption

Absorption refers to the extent to which individuals immerse themselves fully and concentrate deeply on their work activities (Dunlop and Scheepers, 2023). When employees experience absorption, they are so engrossed in their tasks that they lose awareness of time and become wholly immersed in their work. This state of flow is characterized by a heightened level of concentration, complete involvement, and a sense of enjoyment in the work itself (Khusanova *et al.*, 2021). Additionally, absorption was previously described as being fully focused and happily attached to one's work, with the employee feeling that time passes quickly and facing difficulties detaching from work (Talebzadeh and Karatepe, 2020).

Individuals in a state of absorption are highly focused on their tasks, experiencing an elevated concentration that enables them to perform at their best (Luu, 2019). Absorption often distorts time perception, with individuals feeling that time passes swiftly due to their deep engagement in work (Rabiulet *et al.*, 2022). The motivation to work stems from the inherent enjoyment and satisfaction derived from the tasks at hand, rather than external

factors. Those experiencing absorption find the work engaging and may describe the experience as effortless, despite the high level of concentration. Absorption is linked with positive emotions such as enjoyment, satisfaction, and a sense of accomplishment (De-Coning, 2020).

The state of absorption is considered desirable in the context of work engagement as it signifies a high level of intrinsic motivation and a positive psychological connection to the work (Cesário and Chambel, 2017). Employees frequently experiencing absorption are likely to find their work meaningful and rewarding, resulting in elevated levels of job satisfaction and performance (Khoreva and van-Zalk, 2016). Organizations often aim to create conditions supporting absorption, such as providing challenging tasks, promoting autonomy, and recognizing and leveraging employees' skills and strengths (Sarwar *et al.*, 2020). Thus, this study views absorption as an essential catalyst for employee performance in any organization, where employees become deeply engaged in their tasks, losing track of time and fully absorbing themselves in their work.

2.1.2.4 Teamwork

Teamwork denotes the collaborative effort of a group of individuals working together towards a shared goal or objective. It entails the coordination, cooperation, and contribution of each team member, leveraging their skills, knowledge, and resources to achieve tasks more efficiently and effectively than if pursued individually (Navajas-Romero *et al.*, 2022). Successful teamwork is marked by open communication, mutual support, and a collective commitment to the team's mission (Gülbahar *et al.*, 2022).

More so, Team members actively collaborate, pooling their strengths and expertise to achieve common goals. Collaboration involves the exchange of ideas, feedback, and information (Rowan *et al.*, 2022). Effective communication is vital for successful teamwork, necessitating clear expression of thoughts, active listening, and transparent information sharing. Coordination is essential to ensure that individual efforts align with the overall objectives of the team, involving planning, task organization, and efficient resource management (Hopeapuro, 2019).

Teams must also be adaptable to changing circumstances and challenges, open to new ideas, and flexible in adjusting strategies to navigate uncertainties (Kusumiartono *et al.*, 2022). Conflict resolution skills are crucial as conflicts may arise, and addressing them openly and collaboratively can strengthen team relationships and performance (Mijakoski *et al.*, 2015). Teamwork is essential in various settings, including workplaces, sports, educational institutions, and community organizations, contributing to increased productivity, innovation, job satisfaction, and a sense of belonging among team members (Epstein *et al.*, 2022). Effective teamwork demands strong leadership, clear communication, and a shared commitment to common goals (Mijakoski *et al.*, 2015).

Moreover, teamwork creates a foundation for positive work engagement by fostering collaboration, support, and a sense of belonging. Organizations prioritizing and nurturing effective teamwork are likely to witness increased levels of employee's engagement, leading to improved performance and overall job satisfaction (Ullah and Khattak, 2018). Therefore, in this study, teamwork is conceptualized as the collaborative effort of a group of individuals working together towards a common goal or objective—an element that can promote cooperation and collaboration, involving subordinates in the decision-making process, leading to higher employee performance, increased productivity, reduced operational costs, and enhanced customer relations and satisfaction.

2.1.3 Employees performance

Employee performance refers to the level of effectiveness and efficiency with which an individual carries out their job responsibilities and contributes to the overall goals and objectives of an organization. It is a multidimensional concept that encompasses various aspects of an employee's work, behavior, and outcomes (Neuberet *et al.*, 2022). Apparently, Performance evaluations are commonly conducted by organizations to assess and provide feedback on employees' contributions. These evaluations help identify areas of strength, areas for improvement, and opportunities for development. Effective performance management practices contribute to employee growth, job satisfaction, and overall organizational success (Corbeanu and Iliescu, 2023).

However, Employee performance is reflected as an aggregated value to an organization by the set of behaviors that an employee contributes in both forms as directly and indirectly to the organization goals (Corbeanu and Iliescu, 2023). Job performance consists of task performance or in-role performance and contextual performance or extra-role performance. On the whole, job performance is referred as a function not only of task performance but also of contextual behavior like counterproductive behavior (CWB) (Neuberet *et al.*, 2022).

The performance of an employee indicates the outcome of the employee efforts (monetary and non-monetary) that has a direct connection with the attainment of organizational performance and its success (Tian *et al.*, 2019). Past studies connote that the best way for enhancing the employee performance is to concentrate on the promotion of employee engagement (Corbeanu and Iliescu, 2023; Neuberet *et al.*, 2022; Tian *et al.*, 2019).

Consequently, to this, performance is being measured using one of these forms: Financial measures and non-financial measures or a combination of the both (Bakar *et al.* 2015; Wanjauet *al.*, 2015; Koitamet and Ndemo, 2017; Ismanu and Kusmintarti, 2019). Financial measure are related to monetary instruments derived from accounting record (Kont  et *al.*, 2019; Kraus *et al.*, 2012) with specific indicator such as gross margin, profitability, return on investment, gross operating profit and operating income.

On the other hand, non-financial performance uses non- monetary instruments to provide explanations on how well a bakery is doing (Ogbuet *al.*, 2019; Bakar *et al.*, 2015; Wanjauet *al.*, 2015). Although, this employee's performance measure has no financial element but they are considered as main indicators affecting financial measures (Laukkanen *et al.*, 2013). The indicators of non-financial performance are; increase in productivity customer satisfaction ethical behavior, service quality, product acceptance (Suleiman *et al.*, 2011; Samilogluet *al.*, 2017; Ismanu and Kusmintarti, 2019). Therefore, this study adopts the non-financial performance measure discussed earlier. The rationale for this study is premised on the fact that studying bakery based on increase in productivity will give an informed perspective as to whether or not the value proposition do satisfy bakery business objectives.

Interestingly, excellent employee performance creates outcomes like high quality and high productivity among employees in the organization (Kuswati, 2020). The morale and energy of the employees will be boosted when people surrounding them are doing their job effectively (Heeet *al.*, 2019). The way on how organization communicates with its employee reflects the performance of its employees. Effective communication allows employees in an organization to become productive and efficient (Kuswati, 2020). For the purpose of this study, employee's performance will be conceptualized in term of increase in productivity. The rational for the selection is based on the fact that the goal of an organization can only be achieve if employees drive fun in executing task.

6.0 Conceptual Framework

The conceptual framework outlines the independent and dependent variables as discussed in the literature review and elaborated in the figure 1.0 below

Work engagement

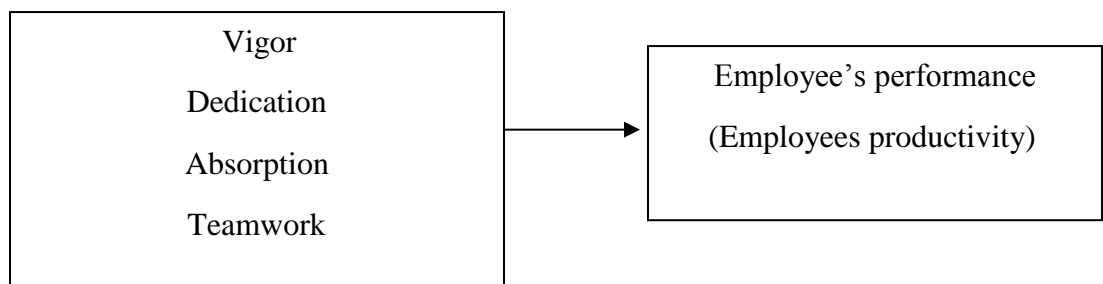


Figure 1.0 –Work Engagement

Source: authors (2024)

It can be observed from Figure 1.0 that this study expects the respondents' perception about work engagement in terms of Vigor, Dedication, Absorption and Teamwork to determine their overall level of employee's performance.

7.0 Work engagement theory of kahn

The work engagement theory of Kahn, developed by William A. Kahn, focuses on the psychological state of engagement or involvement that employees experience in their work

(Kularet *al.*, 2008). Kahn proposed that engagement involves three dimensions: physical, emotional, and cognitive. Here's a breakdown of Kahn's theory of work engagement:

- i. **Physical Engagement:** This dimension refers to the extent to which employees invest their physical energy and effort into their work roles. It involves being physically present, participating actively, and exerting effort to accomplish tasks and goals.
- ii. **Emotional Engagement:** Emotional engagement relates to the depth of an employee's emotional connection to their work, colleagues, and organization. It encompasses feelings of enthusiasm, passion, and dedication toward the work they do. Employees who are emotionally engaged tend to experience positive emotions such as enjoyment, satisfaction, and pride in their work.
- iii. **Cognitive Engagement:** Cognitive engagement involves the extent to which employees are mentally absorbed and focused on their work tasks. It reflects the level of concentration, absorption, and immersion in one's work activities. Engaged employees demonstrate high levels of cognitive vigor, concentration, and absorption in their tasks, leading to a state of flow where they lose track of time and become fully immersed in their work.

Kahn's theory suggests that when employees experience high levels of engagement across these three dimensions, they are more likely to exhibit higher levels of job performance, job satisfaction, organizational commitment, and overall well-being. Conversely, low levels of engagement may lead to decreased motivation, job dissatisfaction, burnout, and turnover intentions (Crawford *et al.*, 2013).

Kahn also emphasized the role of job characteristics, organizational culture, and leadership in fostering employee engagement. Factors such as meaningful work, autonomy, social support, feedback, and opportunities for skill development can enhance employee engagement by fulfilling their psychological needs for competence, autonomy, and relatedness (Shuck *et al.*, 2011). Kahn's work engagement theory highlights the importance of creating work environments that promote a sense of purpose, autonomy, mastery, and social connection to foster high levels of engagement and well-being among employees.

The significance of Kahn's theory of work engagement lies in its contribution to our understanding of the psychological state of employees in the workplace and its implications for organizational effectiveness (Soane et al., 2012).

. Here are some key aspects of the significance of Kahn's theory:

- i. **Holistic Understanding of Engagement:** Kahn's theory provides a comprehensive framework that considers engagement as a multidimensional construct encompassing physical, emotional, and cognitive dimensions. This holistic perspective offers a more nuanced understanding of how employees connect with their work beyond mere task performance.
- ii. **Employee Well-being and Performance:** By focusing on the positive psychological state of engagement, Kahn's theory highlights the link between employee well-being and organizational performance. Engaged employees tend to experience higher levels of job satisfaction, commitment, and overall well-being, leading to improved job performance, productivity, and organizational outcomes.
- iii. **Identification of Key Drivers of Engagement:** Kahn's theory identifies various factors that contribute to employee engagement, including job characteristics, organizational culture, and leadership behaviors. Understanding these drivers enables organizations to design work environments and practices that promote higher levels of engagement among employees.
- iv. **Prevention of Burnout and Turnover:** Engaged employees are less likely to experience burnout and turnover intentions compared to their disengaged counterparts. By fostering a sense of meaning, autonomy, and social connection in the workplace, organizations can mitigate the risk of burnout and retain talented employees.
- v. **Enhancement of Organizational Culture:** Organizations that prioritize employee engagement tend to cultivate positive organizational cultures characterized by trust, collaboration, and innovation. Engaged employees are more likely to contribute positively to the organizational culture, leading to greater resilience and adaptability in the face of change.

- vi. Competitive Advantage: Engaged employees are often more committed to organizational goals and more willing to go above and beyond their job requirements. As a result, organizations with high levels of employee engagement can gain a competitive advantage through increased innovation, customer satisfaction, and overall performance.

Kahn's theory of work engagement serves as a valuable framework for organizations seeking to create fulfilling and productive work environments that benefit both employees and the organization as a whole. By fostering employee engagement, organizations can improve job satisfaction, performance, and well-being, ultimately contributing to long-term success and sustainability.

Critics argue that this emphasis may overlook potential negative consequences or fail to consider contextual factors that could influence outcomes and also it was criticize on the ground that is being too conceptual to measure concretely (Soane et al., 2012).

4.2 Theory selection process for the study

For this paper, work engagement theory of Kahn is adopted as the theoretical lens through which the relationship between work engagement and employee's performance will be investigated. Work engagement variable: vigor, dedication, absorption and teamwork are seen as the only way to discover new opportunities which must be exploited to enhance performance and productivity, however, this theory was seen as appropriate as it is the most suitable for this study because it has a relationship between work engagement and employee's performance among registered bakeries in Suleja emirate.

More so, it discusses on how employees can show different kinds of commitment in actions and attitudes, Kahn proposed that engagement involves three dimensions: physical engagement, emotional engagement, and cognitive engagement. Physical engagement is directly talking about our first variable vigor, emotional engagement is talking about dedication and teamwork while cognitive engagement is talking about absorption of employees in his work in such a way that daily activity levels and confidence in regular tasks, creative contributions and decision making, and regard for the organization and

company loyalty. William Kahn's work promoted a deeper understanding of employee's needs and a more holistic approach to employee engagement. Instead of championing short-term motivational tactics, organizations turned to more cohesive strategies that sought to support staff in all areas of need.

8.0 Limitation and Future Research Direction.

The current study has some limitation: Work engagement may not have the same impact on all employees. Individual differences such as personality traits, personal circumstances, and job characteristics could moderate the relationship between engagement and performance. Work engagement is often measured using self-report surveys, which may be subject to biases such as social desirability or response distortion. By addressing these limitations and pursuing these research directions, Further investigation into these factors could provide insights into when and for whom engagement is most beneficial and explore alternative measurement approaches or develop more robust measures to overcome these challenges.

6.0 Conclusion and Recommendation.

In conclusion, the relationship between work engagement and employees' performance is complex and multifaceted. While there is substantial evidence to suggest that higher levels of work engagement are generally associated with better performance outcomes, several limitations and areas for future research exist. However, individual differences and contextual factors play a significant role in shaping the relationship between work engagement and performance. Recognizing that the impact of engagement may vary across different employees and organizational contexts is crucial for developing targeted interventions and strategies.

In light of these considerations, the paper recommend that organizations take a holistic approach to fostering work engagement and enhancing employees' performance, create a supportive work environment that fosters engagement by providing opportunities for autonomy, mastery, and meaningful work. By implementing these recommendations and

staying attuned to the evolving research in this area, organizations can create environments where employees are engaged, motivated, and performing at their best.

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**DIFFUSION OF INNOVATION: A CONCEPTUAL REVIEW FROM THE
PERSPECTIVE OF PRODUCT DEVELOPMENT.****Kareem, O.W., Ijaiya, M. A. (PhD.)**waheedkareem97@gmail.com, 08033087764, mkijaiya@gmail.com, 07030224131.^{1&2} Department of Entrepreneurship, School of Innovative Technology, Federal University of Technology Minna, Niger State, Nigeria.**ABSTRACT.**

Firm performance is driven by innovation, particularly product and process innovations. Creativity is an integral part of an innovation which is defined by fresh and relevant ideas. Innovation process involve the effective execution of generated ideas. The ideas generated can be those related to products, practices and processes, policies and systems that have direct impact on business development and firm performance. The aim of this study is to review the diffusion of innovation in SMEs. To a greater extent, food companies embrace product innovation and process innovation. Which is why their innovation can be revealed in their product development practice. Their efforts should be dedicated on product improvement, because; product improvement is linked to SME competitiveness and performance. The diffusion of innovation theory maintained that innovations should be compatible with the interests, needs and background of the user, and its evaluation should not be complex because users are interested with innovations that are simple. The study will add to the existing literature of innovation.

Keywords: *diffusion, innovation, product, improvement, performance.*

Introduction.

Innovation is everywhere today. Organizations are including the term innovation in their vision, mission, and objective statements. The position of chief innovation officer is becoming more commonplace. And centers for innovation are popping up on university campuses. The work of Krans *et al*, (2021); and Henrekson *et al*, (2024)., Schumpeter in 1934 put forward the important roles placed by innovation in economic development, Innovation has been generally regarded as a key factor affect for firm performance. Many organizations try to achieve higher profits through innovation in different ways. Creativity is defined by Singh and Aggarwal, (2022)., Sawyer and Henriksen, (2024)., as fresh and relevant ideas is an integral part of innovation which involves effective execution of the generated ideas. Ideas generated can be related to products, practices and processes, policies and systems (Farida and Setiawan 2022; Syofya and Chatra, 2022)., which have direct impact on business

development. Khanraet *al*, (2022); Sugiarti, (2022)., believed Innovation can be very effective when supported by firm resources, and favourable working conditions.

The ubiquity of innovation

Innovativeness is a noun but describes the capability and capacity for innovation. Troøyen and Popp, (2022); Daher-Armache, (2023) defined the term innovation in one of the two ways: “(1) the introduction of something new, or (2) a new idea, method, or device”. Although, the two definitions represent important distinctions; the first definition presents innovation as an outcome while the second definition presents innovation as a process. For better understand of innovation, innovation should be thought of as both an outcome and process. Defining innovation as only one aspect according to Abbasiet *al*, (2022); and Edleret *al*, (2023)., will fall short in its pursuit. Organisation focusing on outcome innovation will minimize process and will lead to inefficiencies such as duplication of effort and resource overconsumption, and organisation that are preoccupied with process often create organisation bureaucracies that make it difficult to manifest outcome (Daspitet *al*, 2023; and Smit and Lawson 2023)., Balancing the view that encompassed outcome and process is crucial with a necessary consideration of mindset. Understanding innovation require thinking around outcome, process and mindset.

Conceptual Review

Diffusion of innovation

Diffusion of innovation theory assert that innovation should be compatible to the users' interest, needs and background that evaluating it should be based on simplicity because users are interest in innovation that is simple and easy (Shaw *et al*, 2022). The theory also suggested that uncertainties regarding innovations should be dismissed and confusions resolved (Farjoun and Fiss, 2022; and Williamsson and Moen, 2022). Nevertheless,innovation outcome should be easily observed, and be able to provide relativeadvantages (Taqueset *al*, 2021; and Shamoutet *al*, 2022). In this regard, firms are likely to adoptinnovations that will foster their performance, and the adoption of innovations by firms will depends on the available firm resources such astechnical know-how, willingness of the work force, capabilities in managing product development and innovation

processes, relative advantage, and the support of the management who are responsible for managing the innovation process in the firm (Chowdhury *et al*, 2023 and Pihlajamaa, 2023). Adoption of innovation by firm is also influenced by the perception of the management about innovation (Hermundsdottir and Aspelund, 2021; and Yuen *et al*, 2021). The management need to adopt employees, innovation in order to adapt to change in the business environment brought by innovation. The particular innovation adopted need to be put to test. In this regard, capacity to test innovation should be acquire by the firms and necessary training should be provided in the firms to enable the firm adapt to business environment changes. (Krammer, S. M. 2022 and Santa-Maria *et al*, 2022).

Innovation as an Outcome

Innovation according to Nandal *et al*,(2020) and Bradley *et al*,(2021)., is emphasised as an outcome which is typically associated with introduction of new products and new services, this is termed as product innovation. Innovation is one of several avenues for outcome opportunities. Innovation as an outcome includes but not exhausted; product innovation; process innovation; marketing innovation; business model innovation; supply chain innovation and organisational innovation (Raz *et al*, 2021 and Casciani et al, 2022).

Product innovation; this referred to market offering of new product, new services, or new programs. Because innovation ranges from incremental to radical offerings, different types of innovation are possible (Hron et al, 2022; Kerzner, 2022). Kristensen and Mosgaard, (2020)., recognized seven types of product innovations as follows:

Cost reductions: These represent a permanent change in price and do not normally have a dramatic change in the visual characteristics of a product. The aim of the cost reduction according to Lina, 2022., is to differentiate the product from competing products on price or ensure the product remains price competitive.

- **Product improvements:** Enhancements that im-prove form or function. Shen *et al*,(2022).,a product improvement will replace the original product so the original product will no longer be available to customers. Product improvements often represent those offerings labeled as ‘new and improved’ or ‘bet-ter.’

- **Line extensions:** New features/options added to an existing offering, which provide unique benefits and functionality that the original product or current set of product offerings does not have (Mahmood *et al*, 2022).
- **New markets:** Current offerings taken to new markets with minimal changes to the product (Markovic *et al*, 2021).
- **New uses:** Original products positioned in new markets without minimal, if any, changes to the product (Paley, 2021).
- **New category entries:** Products that are new to the company, but not new to the consumer as a category (Featherman *et al*, 2021).
- **New-to-the-world products:** Technological innovations that create a completely new market that previously did not exist. These innovations would be characterized as radical (Raddatset *al*, 2022). Introduction of a new drug that treats a medical condition previously not addressed is indicative of a new-to-the-world product.

Process innovation: this is pertaining to changes in a methodology or process to achieve efficiency such as faster processing, greater throughput, or lower cost (Gholamiet *al*, 2022). Production systems, service delivery systems, and organizational processes are fertile areas for process innovation.

Marketing innovation: this innovation aims to connect with customers and consumers on new and different levels and may include new types of promotional efforts. In this way, a marketing innovation serves to drive demand by creating awareness, brand recognition, and product uniqueness (Rizvanovićet *al*, 2023). A marketing innovation is not usually something that is sold directly to final consumers.

Business model innovation: this innovation type is an outcome that change the industry environment (Du *et al*, 2021). There are three main types of business model innovation; industry model innovation, revenue model innovation and enterprises model, these models can be used alone or combined.

- Industry model innovation involves innovating the industry value chain by moving into new industries, redefining existing industries, or creating entirely new ones by identifying/leveraging unique assets of the organization.

- Revenue model innovation is the generation of revenue through offering reconfiguration of the product/service/value mix and pricing models.
- . Enterprise model innovation is innovating the role played in the value chain by changing extended enterprise and networks with employees, suppliers, customers, and others, including capability/asset configuration

Supply chain innovation: A change (incremental or radical) within the supply chain network, supply chain technology, or supply chain processes or combinations of all, that can take place in a company function, within a company, in an industry or in a supply chain in order to enhance new value creation for the stakeholder (Kocabasoglu-Hillmeret *al*, 2023). Three interacting elements of supply chain were highlighted; supply chain network structure, supply chain technology and supply chain business processes.

Organisational innovation: this innovation type addresses changes in the organisation. The change may occur in organisation structure, new forms of management and change or new work environment (Griffin, 2022).

Innovation as a Process: this type of innovation specifically attends to the way in which innovation is and should be organised in a way that the outcome can come to fruition (Baak, (2023). This model of innovation portrays three phases; discover, develop and deliver. In the discover phase, the organisation scans the landscape for potential opportunities and delineates these opportunities. According to Furret *al*, (2022)., promising opportunities enter develop phase where technical specification is determined, and the offer in the deliver phase is introduced and put to purposeful use which could include being sold in the market place. Invention is taking new knowledge and creating something that had not existed before (Berners-Lee et *al*, 2023). Ideation is the creative process that under-lies idea generation. Innovation according to Arekranset *al*, (2023)., is more than ideas and creating something new; execution in terms of getting the offering into the hands of consumers, having purposeful use, and achieving market acceptance is an essential part of innovation. Delivery phase according to Bocken and Konietzko, (2022)., is an important part of innovation, because organisation can not say to have achieved any innovation without the value created getting delivered to the consumer. Another consideration associated with innovation as a process is the new product development (NPD) process.

Innovation as a Mindset: this addresses the internalization of innovation by individual members of the organization and advancement of a supportive culture throughout the organization (Audretsch and Guenther, 2023). Innovation has the propensity to flourish when employees and the organization as a whole instill and ingrain innovation, which in turn predicates the emergence of favorable innovation characteristics. According to Schiuma *et al*, (2022), five skills push new ways of thinking, spur and support innovation, and represent distinguishing features of organizations known for innovation: 1. Associating; is drawing connections between questions, problems, or ideas from unrelated fields; 2. Questioning; is posing queries that challenge common wisdom; 3. Observing; is scrutinizing the behavior of customers, suppliers, and competitors to identify new ways of doing things; 4. Experimenting; is constructing interactive experiences and provoking unorthodox responses to see what insights emerge; and 5. Networking; is meeting people with different ideas and perspectives. These skills applied at both individual and organization levels, they prepare and enable the individual and organization to think differently, laterally, and expansively.

Understanding Innovation makes it Attainable: the pervasiveness of innovation has resulted in overuse and misunderstanding, important of innovation have made it a requisite for longevity of an organization (Kuratko *et al*, 2023). For organization to truly reap the benefits of innovation, innovation must be understood to be an outcome, a process, and a mindset.

Innovation and Creativity in SMEs

Creativity according to Sawyer and Henriksen, (2024), is an integral part of innovation which is the generation of fresh and relevant idea. Innovation process according to Kutiesha and Farmanesh, (2022), involve effective execution of generated ideas related to products, practices and processes, policies and systems that have positive impact on business development. Creativity according to Nasiret *et al*, (2022), will be effective when supported by firm resources and favourable working conditions of the organisation which are likely to drive employee motivation. In the componential theory of innovation creativity, Sawyer and Henriksen, (2024), confirmed that any normal person is able to create something in a particular field under the influence of particular social environment. This makes creativity to be characterised by expertise, creative-thinking skill, and intrinsic task motivation.

According to Ramírez-Montoya, M. S. (2022), expertise involves problem solving capabilities embedded in relevant knowledge, and technical knowhow. On the other hand, creative thinking involves problem solving capabilities that are supported by knowledge and practice (Amabile, 1997). Intrinsic task motivation tells that a person who is intrinsically motivated to execute particular tasks including challenging tasks is likely to reveal creativity (González-Pérez *et al*, 2022). Innovation practices include creativity (Sawyer and Henriksen, 2024). Likewise, innovation in SMEs depends on creativity. In this regard, creativity can influence the development of innovative products (Sawyer and Henriksen, (2024). Ultimately, innovative products influence greater sales in SMEs and reflect the needs of the markets, and customers (Jeong *et al*, 2023). Innovation practices and capabilities depend on the effectiveness of the SMEs' internal environments. Any effective innovation strategy is dependent upon decision making process, and SME's resources and structures (Popa *et al*, 2022). Innovation practices and the management of innovation processes require the support of SME owners/managers (Olazo, 2023). An effective innovation process also requires the involvement of customer's interest (Xie *et al*, (2022). That is why there is evidence in the findings of Srisathan *et al*, (2023), where SMEs seek to manage their innovation initiatives in a participatory manner and Knowledge sharing avenue such as brainstorming session can influenced the innovation in SMEs (Nguyen *et al*, 2024). This session according to Mdhlalose, (2024), define the favourable working environment needed to improve the innovation in SMEs, and through such session according to Lengnick-Hall and Neely, (2023), employees are more likely to acquire knowledge and utilised it in the development of products. It was believed by Tajeddini *et al*, (2023), that the initiative needs to be supported by the owners/managers is by providing strategic and operational solutions and that Supportive working climate influence employees' commitments. According to Alkhalaf and Al-Tabbaa, (2024), to have an effective utilisation of resources, employees of SMEs need to be empowered particularly through training that will stimulate innovation in SMEs and rewards, which are drivers of creativity relevant skills in SMEs.

Conclusion

There a lot of conclusions that can be drawn from the findings. Its findings shows that a favourable output and sales performance is achieved when SMEs seek to improve their

innovation practices by fully involving their competent workforce that is easily manageable. This is a workforce that is innovative, competent and committed, can access relevant business information, training, and experience, and receives appropriate rewards and support from their owners/managers.

In conclusion, there are three different views on the impact of innovation on enterprise performance. The first point of view is that innovation can directly affect the performance of enterprises, showing positive, no effect, or negative effect. The second point of view is that some moderating variables affect the relationship between innovation and business performance, and the main moderating variable is the industrial environment or market environment. The third view is that the mediating effect between innovation and enterprise performance, the main mediating variables include the change of industry, innovation output, IT investment, product matching and process matching, innovation, market position etc. The summary of these researches can provide the direction for further research, on the other hand can also help us recognize the mechanism between innovation and enterprise performance, which can improve the performance of innovation.

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ENTREPRENEURIAL VALUE CHAIN AND RURAL DEVELOPMENT: A STUDY OF RICE FARMERS IN SELECTED LOCAL GOVERNMENT AREAS OF NIGER STATE

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ABSTRACT

One of the major impediments to rural development is the lack of entrepreneurial value chain in production as most agricultural produce meant for the market are always in their primary form. Secondly, an estimated 30% of agricultural produce in rural areas is wasted because of constraints in weak rural value chains. The study examines entrepreneurial rice value chain and rural development in selected communities of Niger state. To achieve this objective, 433 respondents mainly farmers drawn from the population of 953 registered farmers were targeted using quantitative approach and purposive sampling. A structured questionnaire was used as instrument of data collection. Data collected was analyzed using both descriptive and inferential statistical tools. The study found that entrepreneurial value chain primary and secondary activities have significant positive effect on rural development in Niger State. The study recommends that policy makers in Niger State should have as a major policy objective that promotes entrepreneurial value chain in primary and secondary agricultural activities by investing on extension services and other capacity enhancement programmes to open up the rural areas for rapid development and poverty reduction.

Keywords: Entrepreneurial Value Chain, Rural Development, Rice Farmers, Niger States

Introduction

In Nigeria, previous rural development efforts have taken many forms including agricultural development, rural based industrialization, infrastructural development and integrated schemes combining all the elements of agriculture, industry and infrastructure. Strategies for rural development have also come in various shapes and sizes.

There appears to be no definitive answer to a most plausible and effective way of improving the lives and conditions of rural people even when contemporary events around the world have shown increasing concerns for the 75 per cent or more people inhabiting the rural areas. This is justified by the high correlation that exists between rural living and poverty with this situation particularly exacerbated for developing countries (World Bank, 2020).

Rural development is the process of improving the quality of life and economic well-being of people living in rural areas, often relatively isolated and sparsely populated areas. For rural development to occur and endure there has to be enhanced rural income, reduced poverty and unemployment, reduced inequalities, increased rural value-added production and increased infrastructural facilities (Moseley, 2003; Ataei, Ghadermarzi, Karimi, & Norouzi, 2020). Value chain has been acknowledged to be a prime mover of sustainable rural development (United States Agency for International Development (USAID), 2010; Onwualu, 2012). This refers to the full range of activities that are required to bring a product or service from conception through the different phases of production to delivery to final consumers and disposal after use (Morris, 2001). Value chain therefore has the propensity to turn rural dwellers to be mechanized farmers, input providers, processors, wholesalers, retailers, etc.

Recently, there has been increased attention on entrepreneurship as the central force of economic growth and development by most economies of the world. Rural development is more than ever before linked to entrepreneurship. Institutions and individuals promoting rural development now see entrepreneurship as a strategic development intervention that could accelerate the rural development process. Furthermore, institutions and individuals seem to agree on the urgent need to promote rural value chain. Development agencies see entrepreneurial value chain as an enormous employment potential, politicians see it as a very good strategy to prevent rural unrest as well as preventing rural urban migration; farmers see it as an instrument for improving farm earnings; and women see it as an employment possibility near their homes which provides autonomy, independence and a reduced need for social support (Bjorklund, 2020; Nicholaus & Wim, 2022).

However, the acceptance of entrepreneurship as a central development force by itself will not lead to rural development and the advancement of rural enterprises. What is needed in addition is an environment enabling entrepreneurship in rural areas. The existence of such an environment largely depends on policies promoting rural value chain (Cruickshank, Grandelis, Barvwitzki, & Bammann, 2022).

The broad objective of the study is to comparatively study the relationship between entrepreneurial value chain and rural development in Kebbi and Niger States. To achieve this, the study sought to achieve the following specific objectives:

- i. To evaluate the impact of entrepreneurial value chain on rural development in the selected areas of Kebbi and Niger States in the study area.
- ii. To evaluate the impact of secondary activity of the entrepreneurial value chain on rural development in the selected areas of Kebbi and Niger States in the study area.
- iii. To assess the influence entrepreneurial value chain exerts on rural development in the selected areas of Kebbi and Niger States

Thus, the following four hypotheses were formulated for empirical test:

H₀₁: The primary activities of entrepreneurial value chain have no significant impact on rural development in the selected areas of Kebbi and Niger States in the study area.

H₀₂: The secondary activity of entrepreneurial value chain has no significant impact on rural development in the selected areas of Kebbi and Niger States in the study area.

2. Literature Review

The value chain concept comes from business management and was first described and popularized by Michael Porter in his 1985 best-seller, the competitive advantage: creating and sustaining superior performance.

A value chain is a chain of activities that a firm operating in a specific industry performs in order to deliver a valuable product or service for the market. The idea of value chain is based on the process view of organizations, the idea of seeing a manufacturing (or service) organization as a system, made of subsystems each with inputs, transformation process and outputs (Gurria, 2012). It exists when all the stakeholders in the chain operate in the way to maximize the generation of value along the chain. This definition can be interpreted in a narrow or in a broad sense. Entrepreneurial value chain therefore, refers to the creativity and

innovation that takes place across a value chain. When applied to this study, it refers to creativity and innovation in inputs, production, processing, packaging and marketing that takes place across the rice value chain (Gurria, 2012). Many everyday products, from food stuffs, to cosmetics, medicines, clothing and furniture can be traced back through value chains to rural areas, where they are first produced and harvested. Value chains can be local, national or global, linking rural producers with traders and consumers worldwide (Zaman, Abdul, Otiwa, Odey, Adaaja, & Raji, 2019).

The concept of rural development in Nigeria lacks a unified definition as different scholars tend to view it from varying perspective. Some scholars look at rural development from the aspect of education/ training like Haddad (1990), and Hinzen (2000). Obinne (1991) perceived rural development to involve creating and widening opportunities for (rural) individuals to realize full potential through education and share in decision and action which affect their lives. He views efforts to increase rural output and create employment opportunities and root out fundamental (extreme) cases of poverty, disease and ignorance. Others like Timothy and Domenico (2021) view rural development as the provision of basic amenities or infrastructure, improved agricultural productivity and extension services and employment generation for rural dwellers. Dwivedi, Agrawal, Jha, Gastaldi, Paul, & D'Adamo (2021) argued that the definition of rural development has evolved through time as a result of changes in the perceived mechanisms and or goals of development. They further explained that a reasonable definition of rural development would be: development that benefits rural populations; where development is understood as the sustained improvement of the population standard of living or welfare. Todaro and Smith (2011) emphasized that rural development encompasses efforts to raise both farm and non-farm rural incomes through job creation, rural industrialization and other non-farm opportunities and increased provision of education, health and nutrition, housing and a variety of related social and welfare services (Ataeiet *al.*, 2020)

3. Methodology

This study adopted a qualitative research approach. This is because the research relied on primary data obtained through a structured questionnaire from farmers in Niger State of Nigeria. Purposive sampling technique was used to select two local government areas –

Gbako and Wushishi, where rice production is predominantly practised (Anyanwu, Ojo, Nmadu& Adebayo, 2023). The population of the study comprised of rice farmers in the selected areas. The total number of registered rice farmers in the chosen two local government areas considered for the study was 953 which consisted of 532 rice farmers in Gbako and 205 rice farmers in Wushishi LGAs. This constituted the population of the study. Data of registered rice farmers in Niger state was obtained from United States Agency for International Development (USAID) and Rice Farmers Association of Nigeria (RIFAN) respectively.

In determining the sample size for the study, Guilford and Flruchter (1973) formula for estimating sample size is used.

The formula: $n = \frac{N}{1 + \alpha^2 N}$

Where:

N = Required sample size

N = size of the population;

α = alpha (0.05)

By substituting the size of the farmers in each of the sampled local government areas, namely Gbako (532) and Wushishi (421) into the formula above, the following sample can be obtained:

$$\text{Sample size (Gbako)} = \frac{sN}{1 + \alpha^2 N} = \frac{532}{1 + (0.05^2)(532)} = 228$$

$$\text{Sample size (Wushishi)} = \frac{N}{1 + \alpha^2 N} = \frac{421}{1 + (0.05^2)(421)} = 205$$

The total sample size for the selected LGAs in the state is summed up to arrive at the total sample size for the study:

$$\text{Total sample size} = 228 + 205 = 433.$$

The total sample size for the study constituted 45% of the total population. Perelomde (1992) and Owojori (2002) affirm that a sample size that is not less than 10 percent of the study population is a good representative of the population. The study used purposive sampling in choosing the two local governments. The justification for choosing these local governments is that in terms of rice production in the state, they are ranked first and second respectively (Anyanwu *et al.*, 2023). The simple random sampling was used in selecting the respondents from the sample size.

The independent variable is entrepreneurial value chain while the dependent variable is rural development. The study investigated the effect of inbound logistics or primary activities such as input supplying, production, and processing; and outbound logistics or secondary activities (activities that delivers product to consumers) on rural development. Consequently, this study developed questionnaire using a 5- point Likert Scale to be administered on the sampled respondents and in order to gauge the perception of the respondents taking into cognizance the research objectives and hypotheses. Regression analysis using Statistical Package for the Social Sciences (SPSS) version 26, was used to estimate the effect of the independent variables on the dependent variable. Two different regression models were used to achieve the objectives of the study. The specification of the of the first model which was used to achieve the first objective was adapted from Anyanwu *et al.* (2023) is as stated below:

$$EVCP = \beta_0 + \beta_1 IPS + \beta_2 PRD + \beta_3 PRC + \mu \quad (1)$$

Where:

EVCP = Entrepreneurial Value Chain Primary Activities

β_0 = Constant

IPS = Input supplying

PRD = Production

PRC = Processing

$\beta_1, \beta_2, \beta_3$ = Coefficients of the independent variables (input supplying, production, and processing).

Similarly, the specification of the second model which was used to achieve the second objective was adapted from Anyanwu *et al.* (2023) is as stated below:

$$EVCS = \beta_0 + \beta_1 TRA + \mu. \quad (2)$$

Where:

EVCS = Entrepreneurial Value Chain Primary Activities

β_0 = Constant

TRA = Trading

The a priori expectations of the relationships between the variables are as expressed below:

Model 1: $\beta_0 = 0$; $\beta_1, \beta_2, \beta_3 > 0$

Model 2: $\beta_0 = 0$; $\beta_1 > 0$

4. Result and Discussion

4.1 Descriptive Result

Personal Information of the Respondents

The demographic features of the respondents are presented in Table 1 using frequency tables and percentages.

Table 1: Demographic Features of Respondents

Variable	Gbako LGA (n=226)		Wushishi LGA (n = 205)		Pooled (n = 431)
	Frequency	(%)	Frequency(%)		Frequency (%)
Sex of Respondents					
Females	75	33	27	13	10223.7
Males	151	67	178	87	329

76.3

Age

Less than 28	132	58.4	109	53.2	241
					55.9

28-54	94	41.6	96	46.8	190
					44.1

Marital Status

Single	43	19	32	15.6	75
					17.4

Married	165	73	166	81	331
					76.8

Divorced/Separated	18	8	7	3.4	25
					5.8

Educational Status

Primary	35	15.5	7335.6		108
					25.1

Secondary	51	22.7	16	8	67
					15.5

OND/NCE	45	20	8	3.9	53
					12.3

HND/Degree	31	13.7	5	2.4	36
					8.4

No Formal Edu.	6428.3	103	50.2	167
				38.7
Experience				
Less than 6	28	12.4	12	5.9
				40
				9.3
6-10	8437.2	44	21.4	128
				29.7
Greater than 10	11450.4	149	72.7	263
				61.0

Sources: Field Survey (2023)

Table 1 presents the general background information of respondents in this study. From the Table, it can be observed that male respondents formed the majority of the sample at 76.3% while female respondents represented 23.7%. With respect to age, 55.9% of respondents fall within the ages of 18 – 27. The rest were within the ages of 28 – 54 years representing 44.1% of the respondents. With respect to marital status of respondents, 76.8% were married, 17.4% single and 5.8% divorced. From the table, it can be observed that most of the respondents (38.7%) had no formal education, 25.1% with primary certificate, 15.5% with secondary school certificate, 12.3% with NCE/ND and 8.4% with BSc/HND. In response to experience in rice farming, 61% had more than 10 years' experience, 29.7% had between 5-10 years' experience and 9.3% had less than 6 years.

4.2 Test of Hypotheses

***Hypothesis I:** The primary activities of entrepreneurial value chain have no significant impact on rural development in the selected areas of Kebbi and Niger States in the study area.*

The above null hypothesis was tested using regression analysis to achieve the first objective of the study. Table 2 shows an extract of the regression estimate generated using SPSS version 26.

Table 2: Regression Estimates of the Impact of EVC Primary Activities on Rural Development

Variable	Coefficient	t-value
Constant	42.1037	(7.92) ***
Input supplying	0.3090	(2.31) **
Production	-0.0835	(-0.49)
Processing	0.6093	(5.51) ***
<hr/>		
R ² = 0.523	F-Statistic –12 (0.000)	

Source: Authors' Extraction from SPSS Output (2023)

The null hypothesis I tested for this study was that the primary activities of the entrepreneurial value chain have no significant impact on rural development in Niger State. An entrepreneurial Value Chain (EVC) primary activity encompasses inbound logistics such as input supplying, production and processing. The result of the regression estimate presented in Table 2 showed that the explanatory variables account for 52.3% of the total variation in the dependent variable as indicated by the R² value of 0.523. The f-value of the model is shown to be significant at 0.000 indicating a good fit. The result also shows that in Niger State, input supplying with t-value of 2.31 and processing activity with t-value of 5.51 were

found to be statistically significant at 5% level of significant. This implies that a unit increase in input supplying and processing will lead to 0.3090 units and 0.6093 units respectively in rural development. By inference, entrepreneurial value chain primary activities such as input supplying and processing had significant positive effect on rural development in Niger State, while production had a negative effect which is also not significant on rural development. Generally, it can be inferred from the results that EVC primary activities has a significant effect on rural development in Niger State. Thus, the null hypothesis was rejected, while the alternative hypothesis which stated that there is a significant impact of EVC primary activities on rural development in Niger State was accepted.

Hypothesis 2: The secondary activity of entrepreneurial value chain has no significant effect on rural development in Niger State.

The above null hypothesis was also tested using regression analysis to achieve the first objective of the study. Table 3 shows an extract of the regression estimate generated using SPSS version 26.

Table 3: Regression Estimates of the Impact of EVC Secondary Activities on Rural Development

Variable	Coefficient	t-value
Constant	58.0439	14.40***
Trading	0.3199	2.59***
$R^2 = 0.443$		F-statistic = 13 (0.047)

Source: Authors' Extraction from SPSS Output (2023)

The result of the regression estimate presented in Table 3 showed that the explanatory variables account for 44.3% of the total variation in the dependent variable as indicated by the R^2 value of 0.523. the f-value of the model is shown to be significant at 0.047 indicating a good fit. The result of the regression estimate presented in Table 3 showed that in Niger State, trading with t-value of 2.59 was found to be statistically significant at 5% level of probability implying that EVC secondary activity like trading had a significant positive effect on rural development in Niger State. It revealed that a unit increase in EVC secondary activities (trading) improves rural development by 2.59 units. Generally, there was significant impact of entrepreneurial value chain secondary activity (trading) in Niger State. Thus, the null hypothesis was rejected, while the alternative hypothesis which stated that there is a significant impact of entrepreneurial value chain secondary activity on rural development in Niger State was accepted.

4.3 Discussion of Findings

The analysis of the results shows significant relationship between the primary and secondary activities of the value chain and rural development. This specifically, was what hypotheses 1 and 2 tested. These results conform to the findings of Jacques (2011) in an exploratory study of the primary and secondary activities of the value chain in developing countries and established a strong relationship between value chain and rural development. Onwualu (2012) in an exploratory survey of rice, maize and cassava value chains in Nigeria found a significant relationship between agricultural value chain and rural development.

The study also found out that there is significant relationship between entrepreneurial value chain and rural development. This result conforms to Titianne (2013) study of small holder dairy farmers in Kenya as well as Zaman *et al.* (2019) in Nigeria who both established a nexus between entrepreneurial value chain and rural development. Borbora and Das (2014) Atayiet *al.* (2021) discovered strong relationship between entrepreneurial value chain and rural development in India and Nigeria respectively.

5. Conclusion and Recommendation

Based on the results obtained from the empirical test of the two hypotheses, the inference could be drawn that in Niger States, there is a significant relationship existing between entrepreneurial value chain and rural development. With the exception of production, other

primary activities such input supplying and processing; and secondary activities such as trade all have significant effects on rural development in NigerStates. It is recommended that policy makers in Niger State should have as a major policy objective that promotes entrepreneurial value chain in primary and secondary agricultural activities by investing on extension services and other capacity enhancement programmes to open up the rural areas for rapid development and poverty reduction.

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AN ASSESSMENT OF THE VARIOUS TETFUND INTERVENTION PROJECTS IMPLEMENTED BETWEEN 2020-2022 IN FEDERAL UNIVERSITIES LOCATED IN NORTH-CENTRAL NIGERIA REGION: A LITERATURE REVIEW APPROACH

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ABSTRACT

A major goal of Nigerian Universities is to achieve an infrastructural development system that would promote the attainment of high academic standards of the universities. The Tertiary Education Trust fund (TETFUND) has over the years assisted the nations institutions through the provision of requisite finances and infrastructures. The study methodology involved in-depth reviews of contemporary literatures on the various intervention projects implemented in the selected Federal Universities of the North-Central Nigeria region between 2020 and 2022. The study revealed that a whopping sum of ₦3,068,446,165.04 was disbursed to the University of Jos making it the largest earner of the entire special, zonal and annual projects for the period reviewed. This study therefore concluded that despite the increment in the performances of the TETFUND in the area of financial disbursement to the various North-Central Universities, more financial inducement leading to more infrastructural development of these universities are required, thus, triggering the need for a possible rise in the financial tax of the companies and donor agencies that provide finances to TETFUND. This study recommended the need for government to raise the assessable profit of TETFUND from 2% to a minimum of 5%.

Keyword: TETFUND Intervention Projects, Infrastructural Projects, North-Central Universities, Nigeria.

1.0 INTRODUCTION

Nigerian higher education institutions have encountered a multitude of challenges, including inadequate financial, personnel, and material resources (Umar, 2020). The government has taken many measures to revive the declining state of the nation's educational sector (Ugwu, 2010; Zakari, 2022). The policy governing higher education in Nigeria is established within the National Policy on Education, along with other matters that are periodically approved by the National Council on Education (NCE), which serves as the supreme authority for educational affairs. Additionally, there are legislated policies that have been enacted into law regarding the operations and management of higher education in the country (Amin et al.,

2020). The policy for higher education in Nigeria is determined by the governments endorsement of the preferred practices and legislation enacted by the current administration, all aimed at achieving the overarching objectives of higher education. The National Policy on Education (NCE, 2000) states that higher education has several objectives. These include: providing high-level and relevant training to produce skilled individuals who can contribute to national development, instilling proper values in individuals for their own survival and the well-being of society, enhancing individuals' intellectual capacity to comprehend and value their local and global surroundings, and equipping individuals with both physical and intellectual skills to become self-sufficient and productive members of society (Aina & Olorunsola, 2023). Furthermore, higher education plays a crucial role in fostering scholarship and community service, strengthening national unity, promoting global understanding and interaction, and providing advanced knowledge and skills to students. It also involves conducting innovative and speculative research to generate knowledge and ideas for the betterment of society (Amin et al., 2020). The national policy on education paper also delineated the methods by which higher educational institutions in Nigeria should attain these aims. These encompass the activities of teaching, research and development, robust staff development, creation and distribution of knowledge, diverse programme modes including full-time and part-time access to training funds such as those offered by the Industrial Training Fund (ITF), Students Industrial Work Experience Scheme (SIWES); adherence to minimum educational standards through relevant agencies; collaboration between institutions, and committed service to the community through extramural and extension services (NCE, 2000).

The global education sector has a crucial role in supplying the necessary educated workforce, promoting socially acceptable norms, and creating the methods and methodologies essential for a nation's prosperity (Iliyasu, 2023). The significance of university education in Nigeria is undeniable (Amin et al., 2020). Nevertheless, the fundamental resources required to ensure the provision of high-quality service delivery within the national educational system are often limited (Ademiluyi, 2021). Given that the progress of the country depends on the survival of the educational system, it is imperative to exert all possible efforts to assure the continued existence and success of these institutions (Amertey, 2022). Various organizations have been

established to oversee the general administration, control, and monitoring of these institutions, based on this concept (Omosidi et al., 2023). This is to empower them to make valuable contributions and improve the economic standing of the country. The Tertiary Education Trust Fund (TETFUND) is a government intervention agency that has been formed to ensure the sustainability of the university system. The nation's tertiary institutions have human, financial, and material limitations, which pose a continuous danger to the level of teaching, learning, research, and community development (Bala, 2018). In order to restore the reputation and former prestige of these institutions, regulatory bodies are utilized to intervene and improve the position of tertiary institutions in the nation's growth by enhancing their efficiency and effectiveness. Several researchers, including Ogar (2012), Adeleye (2013), and Onyeike and Oseyi (2014), have conducted studies on TETFUND intervention at tertiary institutions. However, there is a lack of a thorough literature review specifically focusing on the intervention projects undertaken in the North-Central Universities. Therefore, this study aims to address this gap.

The significance of education in the advancement of any country cannot be overstated (Abdullahi, 2021). The UNESCO recommended that member states allocate a minimum of 26% of their budget on education (UNESCO, 2017). Throughout the year, the Nigerian education system has faced many challenges, with money being the most significant issue (Muhamud et al., 2023). The consequences of inadequate funding for university education have profound and far-reaching effects on both the university system and the broader education sector. This is because universities serve as the central hub of the education system and provide education to other levels of education, such as secondary and primary schools, as well as tertiary institutions like polytechnics and colleges of education (Bagoro, 2019). World Bank (2010) indicates that inadequate financing of education in sub-Saharan Africa has a detrimental impact on the quality and applicability of educational initiatives. Africa is the only area globally to have seen a decline in the magnitude of current public spending per student, with a reduction of 30% over the last 15 years. Universities are facing significant challenges in retaining teaching staff, as lecture halls are becoming overcrowded and buildings are deteriorating. Additionally, there is a lack of investment in research and training for new teachers, resulting in insufficient resources. As a result, many teachers are

forced to seek additional income by offering services to the private sector. The insufficient allocation of resources may result in student protests and strikes, posing a threat to the successful completion of the academic year (World Bank, 2010).

The intervention areas encompass various initiatives such as physical infrastructure and programme upgrades, project maintenance, TETFUND scholarships, teaching practice for COEs, equipment fabrication for Polytechnics, entrepreneurship programmes for Universities, journal publication and manuscript development, conference attendance, ICT support, advocacy, institution-based research, national research fund, and library development (Aprebo and Wey, 2018). Therefore, the areas of intervention include specialized centers of excellence, interventions with significant effects, interventions at the zonal level, catastrophe recovery, a national research fund, and the production of higher education books (Bagoro, 2019). The main objective of this research is to examine the infrastructure projects carried out by TETFUND in the North-Central Federal Universities from 2020 to 2023. This includes projects at the zonal, special, and yearly levels.

2.0 LITERATURE REVIEW

2.1 TETFUND

TETFUND is a significant provider of financial aid to institutions in Nigeria, particularly for the initiation, completion, or restoration of capital projects undertaken by institutions at the Federal, State, and Local Government levels. The majority of the recent capital improvements at our tertiary institutions have been supported or funded by the Fund. It is important to mention that the funds from the ETF were first used to support educational activities across several levels of education, with a distribution ratio of 2:3:5 for Primary, Secondary, and Tertiary institutions correspondingly. As a result of a significant change in policy driven by the dedication of the Federal government to reform the higher education system, TETFUND will henceforth only provide funding to public tertiary schools. As a result, the Fund is now called the Tertiary Education Trust Fund (TETFUND). Thankfully, the amount of money being received by TETFUND has greatly risen as a result of the effectiveness of FIRS in collecting the education tax from registered firms in Nigeria. During the announcement of the special interventions in April 2009, the Minister of Education

emphasized that the education system is undeniably confronting significant difficulties. The successful resolution of these difficulties is a prerequisite for the progress of our country. The Yaradu'a Administration was dedicated to achieving the 7-Point Agenda and our national aspiration of attaining a position among the top 20 global economies by 2020. To achieve success, the country need highly skilled and talented individuals, this can only be developed via top-tier educational institutions. This necessitated a planned allocation of funds towards enhancing the teaching and learning environment, as well as elevating the quality of instructors in our educational institutions.

The Minister of Education emphasized that the primary goal of the special intervention was to provide and enhance facilities to support the essential activities of teaching, learning, and research in crucial areas. This includes the creation of a centralized teaching and research laboratory that adheres to established standards. Additionally, there will be enhancements made to the Science, Technology, and Humanities/Social Sciences programmes, which encompass fields such as Medicine, Engineering, Agriculture, and the Arts/Social Sciences. The intervention aims to develop the courses into centers of excellence and enhance the whole teaching and learning environment, including lecture theatres, classrooms, labs, workshops, and more (Aina & Olorunsola, 2023). This pertains to the restoration and improvement of physical infrastructure, as well as the supply of educational facilities and resources (Bamiro, 2012). Equally significant was the Minister's statement during the same event, stating that the Federal Government acknowledges that the achievement of the 7-Point Agenda and Vision 2020 depends not only on providing facilities, but also on promoting research and scholarly publications (Adaubiele, 2016). Consequently, a total of N3 billion has been authorized to provide financial assistance to our academics, both individually and in groups, for the purpose of doing research that may contribute to the advancement of the country in their respective fields of expertise. Furthermore, a total of N2 billion has been authorized to facilitate the restoration of academic journals, the production of extensively researched textbooks at the tertiary level, and the accessibility of these resources to the libraries of our tertiary institutions. TETFUND has established the necessary infrastructure to carry out the TETFUND Research Fund by inviting researchers inside the system to submit research ideas in three specific areas: Humanities and Social Sciences, Science and

Technology, and Crosscutting Issues (www.etf.gov.ng). The Textbook Project, which has been allotted N2.0 billion, has commenced. TETFUND typically provides support to tertiary institutions through interventions in various areas, including the construction and renovation of buildings and laboratories, acquisition of teaching and research equipment, training of academic staff, research and book development, capacity building and teacher training programmes, provision of ICT infrastructure, and development of facilities such as boreholes and electric power generators that sustain institutions (Bamiro, 2012).

2.1.1 The Scope of TETFund Interventions

TETFUND, as an interventionist agency, has been tasked with the responsibility of providing financial support to all public tertiary institutions in Nigeria. Since its establishment, TETFUND has disbursed monies to public universities, polytechnics, and colleges of education. The number of institutions receiving benefits from the Fund has grown over time. As an example, it increased from 164 in 2012 to 179 in 2014. The total count of beneficiary public tertiary institutions as of 2015 is as stated below: The number of universities is 70, the number of polytechnics is 51, and the number of colleges of education is 5. The categorization of TETFUND Interventions has been authorized by the Board of Trustees and may be outlined as follows:

2.1.2 Normal Intervention

This encompasses the tangible infrastructure, equipment, and the advancement of library resources. Between 2008 and 2015, TETFUND provided financial support for a total of 1068 academic staff members pursuing Masters' and PhD degrees, both domestically and overseas. Additionally, the National Book Development Programme was implemented to incentivize researchers in the creation of publications, particularly derived from their theses. The fund allocated a sum of N2 billion as a seed grant for this initiative (Amerthey, 2022). The establishment of the National Research Fund was prompted by the government's acknowledgment of the crucial role that research plays in the progress of the country. An amount of N3 billion was allocated as a seed grant and placed in the custody of TETFUND. A total of N2 billion seed funding was allocated specifically for the purpose of publishing high-quality learning materials in academic journals. Thus far, a total of more than 200 doctoral dissertations have undergone evaluation, while more than 75 articles have been

received. TETFUND has provided sponsorship for a total of 20,359 academic and nonacademic staff members to attend conferences inside the nation, while 2,869 staff members have attended conferences abroad. The Fund also participated in 84 scholarly Journal articles and 22 manuscript development activities.

Pursuant to the directive from the Office of the President of Nigeria, the National Youth Service Corps (NYSC) has selected exceptional members with first class and second class degrees to receive sponsorship for Masters' and PhD programmes. These individuals are expected to gain admission within six months of the announcement. As a result, the Fund has sponsored sixteen (16) awardees from the 2010/2011 NYSC scheme for PhD programmes, amounting to a total of N583,826,651.00. Between 2012 and 2015, the Fund provided financial support to a total of eighty (80) recipients, amounting to a sum of N1,288,000,438. The Editorial Sub-committee gathered and analyzed 83 Masters' and Doctoral theses that were classified as exceptional by the Nigerian Universities Commission. Theses that were deemed to be of excellent quality were recommended by the Universities. Universities evaluate these theses according to the rules established by TETFUND (Zakari, 2022). Theses that have been selected by Universities are then presented to TETFUND for evaluation by the Technical Advisory Group (TAG). The Editorial Sub-committee conducts a Needs Assessment in the field of basic textbook publishing to identify areas that want immediate attention. Based on their findings, the committee advises TETFUND to engage writers for the creation of basic textbooks (Umar, 2020). TETFUND advertises in national media to solicit the submission of high-quality manuscripts in specialized fields for publication. The adverts include instructions and criteria for those who want to take part in the initiative. Afterwards, the Editorial Subcommittee assesses submissions and provides suggestions to TETFUND for the ultimate selection of papers to be published.

2.1.3 High Impact Intervention

The high impact intervention often focuses on specific details outlined in the Act, while the distribution of resources is based on geographical zones and is determined fairly by the Board of Trustees periodically. The High Impact Intervention aims to provide substantial money to specific tertiary institutions in each of the six geo-political zones. The objective is to bring about significant improvements in academic courses and enhance the teaching and

learning environment. The Board of Trustees selects beneficiaries according to specific criteria established for each stage of the intervention (Aprebo and Wey, 2018). The first cohorts of institutions were the primary recipients of the High Impact Intervention initiative, which began in 2009. Presented here are the several stages. A total of N26.4 billion was provided as a High Impact Special Intervention money to thirteen (13) public tertiary institutions throughout the six geopolitical zones during Phase One. All the recipients successfully obtained their cash. In Phase Two, a total of N24 billion was distributed to twelve (12) institutions throughout the six geo-political zones. In Phase Three, a total of N108 billion was awarded to six (6) institutions in the six geo-political zones. All recipients successfully obtained their cash. In Phase Four, a sum of N24 billion was distributed to twelve (12) universities. Similarly, Phase Five granted a total of N24 billion to 12 institutions (Shuaibu et al., 2017).

2.1.4 Special Intervention

These interventions aim to address imbalances or weaknesses in important areas specified in the Act, as determined by the Board of Trustees. These interventions are provided to institutions in the six geo-political zones to specifically meet their unique requirements. The category includes the following specific interventions:

- a) Equipping TVE laboratories of 51 Federal and State Polytechnics;
- b) Construction and expansion of multi-media micro-teaching laboratories in 59 Federal and State Colleges of Education;
- c) Expansion and completion of Special Engineering and Technology Project (SET) in 73 Federal and State Universities;
- d) Second Phase of Nigeria Universities Electronic Teaching and Learning Platform in 79 Federal and State Universities.

2.2 Effects of Inadequacies in Infrastructure Development and Funding on Performance of Tertiary Institutions on Infrastructure

According to Ezeogidi (2014), it is accurate to assert that the inadequate condition of infrastructure has been a significant obstacle to growth in Nigeria. This remark is neither an exaggeration nor a form of criticism. It is an indisputable reality supported by ample data. The impact of this phenomenon is evident across all sectors of the Nigerian economy and has

direct and indirect implications for the global economy (Okolo et al., 2020). The current state of underdevelopment, characterized by high unemployment and poverty, may be attributed to the inadequate infrastructure facilities that have been set in place. This has resulted in dissatisfaction and despair among the population (Iliyasu, 2023). Furthermore, it resulted in many forms of criminal activities and prompted migration from Nigeria to other nations, particularly those in Southern Africa, Europe, and America. The issue of inadequate financial resources, a significant obstacle faced by the Nigerian University system, has had detrimental impacts on the institutions' performance (Victoria et al., 2021). Fasihul (2013), explains that the consequences of declining resources in the Nigerian University system are shown via many adaptation mechanisms, including:

- (i) Curtailing of laboratory/practical classes.
- (ii) Limited number of field trips.
- (iii) Reduction in the rate of attendance of academic conferences.
- (iv) Reduction in the purchase of library books, chemicals and basic laboratory equipment.
- (v) Embargo on new employment
- (vi) Embargo on study fellowships and (vii) Reduction in research grants away others.

2.4. Evolution of Educational Financing in Nigeria

The allocation of financial resources to Nigerian education may be categorized into two distinct periods: pre-independence and post-independence (Onyeizugbe et al., 2016). Nigeria gained independence in 1960, although the introduction of Western education occurred in the country in 1842. The period from 1842 to 1959 is referred to as the pre-independence era, whilst the period from 1960 to the present is considered the independent and post-independence era (Ajayi, 2018).

2.4.1 Financing of Education during Pre-Independence Era

In 1842, Christian Missionaries brought western education to Nigeria with the intention of converting the local population to Christianity. Initially, the funding for western education was exclusively controlled by various Christian mission organizations. Fafunwa (1974), Adeyemi (1998), and Adesina (1977), have highlighted that Christian Missions provided complete financial support for Western education. This support was obtained via many means such as Sunday school collections, including tithes, offerings, personal gifts, and

contributions from the foreign headquarters of different Missions. Currently, the colonial authorities had a lukewarm attitude since they believed it was outside their jurisdiction and willingness to finance such endeavours. At that time, the colonial authority did not provide any financial support for western education, as stated by Adesina in 1977. According to Fafunwa (1974), the colonial government in Nigeria showed great interest in funding education starting from 1872. Initially, a total of £1000 was allocated for primary education, but this amount was later reduced to £330 and then to £30. However, the funds were distributed equally among the three Missions that operated schools in the Lagos region at that time, namely the Wesleyan Mission, Roman Catholic Mission, and Church Missionary Society. In 1873, according to Fafunwa (1974), the government allocated £300 for the Missions but failed to provide the funds. Between 1874 and 1876, an annual grant of £300 was also sent to the three Missions in order to promote education. This amount was equally divided among the three leading missions at that time. In 1887, the gift was increased to £600 per year. The year 1882 was a significant turning point in the advancement of western education in Nigeria, as it signaled the beginning of direct involvement by the colonial administration in funding education (Akpanuko, 2012). The commencement of this process can be traced back to the implementation of the first Education Ordinance. This ordinance facilitated the funding and assistance for schools established by the colonial administration, as well as providing support via a system of donations for schools established by Missions and private individuals. In addition, schools established by voluntary organizations were sustained by school fees, voluntary memberships, donations from philanthropic organizations, and grants from the government (Omoede, 2015). During the era between 1842 and 1900, it is important to highlight that the Missionaries and voluntary organizations provided a larger quantity of funding for education compared to the colonial administration. The era between 1901 and 1952 saw a greater emphasis on educational finance from Missionaries and volunteer organizations compared to the colonial government. The establishment of Nigeria's educational system was initiated by the Education Ordinance of 1926. Yaba College of Technology, founded in 1947 as Yaba Technical Institute, is the first higher education institution in Nigeria. The Yaba Higher College was founded in 1934 with the purpose of offering advanced instruction in the medical, engineering, and other

professional sectors. In 1945, the Elliot Commission proposed transforming Yaba Higher College into a Technical Institute in order to meet the need for a large number of technicians needed for the economic growth of the nation. After the government accepted the Commission's report, Yaba Higher College was shut down. In its place, Yaba Technical Institute was established in 1947. The students, along with the classroom furniture and laboratory equipment from Yaba Higher College, were moved to Ibadan to form the initial group at the university college, which began in 1948. The Nigerian University System began in 1948 with the creation of University College Ibadan, which was then affiliated with the University of London. The institution received complete financial support for its teaching and research activities via collaborative efforts by the Nigerian and British governments. It is the only university in the nation to have this level of funding (Ajayi, 2018). Between 1948 and 1954, the government allocated more than £3.6 million for capital investment at University College Ibadan, but the total recurring expenditure during that period amounted to £112,269 (NUC, 2003). Between 1960 and 1973, five further institutions, known as the first generation universities, were established in Nigeria after its independence. The institutions performed well and received enough funding from the government. During that time, tuition fees were imposed for various academic programmes, the federal government provided financial support to the institutions annually, and scholarships/grants were made available to economically disadvantaged students (Akintoye, 2008). Okebukola (2002) observed that there was no substantial disparity between the funding requested by the institutions and the amount received from the government. There were instances when the total obtained exceeded the requested amount. For instance, Ejiogu (1986) confirmed that the annual government funding allocated to the first five institutions in the country during that period increased from £2.56 million in 1963/1964 to £5.9 million in 1968/1969. Furthermore, throughout the timeframe of 1960 to 1969, the universities of Ibadan and Lagos had full financial support from the government of Nigeria. In addition to government support, colleges obtained funds from other sources like as private gifts, research grants, and endowments (Fafunwa, 1971).

2.4.2 Financing of Education during Independence and Post-Independence Eras

Nigeria's independence was attained in 1960, and this period was significant as it saw the establishment of specific responsibilities by both the Federal and Regional Governments for the progress of education. It was at this time that the New Federal Government assumed control of schools formerly managed by Missionaries and volunteer organizations. The First National Development Plan (1962-1966) was developed which enabled Federal Government to be in charge of education in the capital city, Lagos and in a few institutions of higher learning while the Regional Government had main duty of education in their districts, although, the Federal government provided financial assistance for education in their respective regions (Omoede, 2015). The first National Development plan accounted for 10% of the total projected public sector and ranked sixth in the distribution of resources to the education sector. Education accounted for 13.5 percent of the total anticipated public sector investment in the Second Development Plan of 1970 to 1974. During this time, the Federal Government prioritised rehabilitation, reconciliation, and restoration efforts as a result of the civil war. These endeavours required significant financial resources. The school enrollment at all levels of education was increased. The provision of funding to institutions had little impact (Omoede, 2015). During the third National Development plan (1975-1980), the allocation to the educational sector decreased to 50, or 7.5 percent of the total National Capital expenditure. The bulk of oil revenue was allocated towards developing essential infrastructure, including roads, electricity supply, water systems, healthcare services, cheap housing, and efficient social programmes, resulting in unprecedented improvements in these areas. The fourth National Development Plan (1981-85) allocated 17.3 percent of its budget for education.

In every National Development Plan, the allocation of cash to education, like other sectors of the economy, did not improve throughout the years. The allocation of funds to the education sector as a percentage of the total annual budget was less than 8% between 1960 and 1995. During the period from 1996 to the present, the distribution level to the sector did not exceed 13.5%, except for 1997 when it reached 17.5%. The military regime that governed Nigeria from 1983 to 1999 managed the education sector together with other areas of the economy (Ajayi, 2018). During the military era, there were persistent labour stoppages, particularly in the education sector, due to inadequate funding allocated to the area. Many times, a part of

the limited funds allocated to the sector was not available owing to economic downturn or a higher proportion of the allocation was misappropriated by individuals (Nwadiani, 1999). The schools experienced depreciation in infrastructure while staff wages were not accounted for owing to limited budget which leads to brain-drain. The current fourth republic, which began in 1999 and continues to the present, may be described as a case of old wine in new skin. Despite the efforts made by previous administrations in the present government to improve the education system via funding, there is still a need for more action in terms of resource allocation (Omoede, 2015).

2.3 Theoretical Review

2.3.1 Human Capital Theory (HCT)

Among the several theories of human capital development, the most suitable one for this research is HCT, as proposed by Becker (1964). The idea acknowledges that the expansion of physical capital stock is heavily reliant on the presence and accumulation of highly skilled and educated workforce, also referred to as human capital (Ezeali, 2017). The concept believed that education, namely via training and skill development programmes, had a positive correlation with worker productivity due to its influence on the acquisition of relevant information and competence within the workforce. Becker's statements imply that implementing or maintaining workforce development initiatives leads to increased or maintained productivity inside the company. The continuous training of professors via TETFund's personnel development initiatives leads to increased productivity and improved organisational performance (Usman & Olure-Bank, 2019). According to Harbison and Myers (2013), the reformation of human capital theory emphasized the importance of education and training as the primary means of engaging in the modern global economy. When human capital or human resources are adequately cultivated via applicable training, the desired result is guaranteed. Experts in organisational management argue that implementing a structured programme for developing human resources through training is crucial for any organization. This is because it leads to higher productivity, improved morale, cost reduction, and enhanced organisational stability and adaptability to external demands (Uyeri, 2016). However, inadequate trainings might result in a significant depletion of limited resources for the government, organization, or person involved. Many developing nations have suffered in

this regard, since they engage in training initiatives that lack a requirements assessment (Adamu et al., 2021).

2.3.2 Goods Theory (GT)

The study is also centered on the theory of goods put forward by Paul Samuelson (1999). The idea of public goods, which was first proposed by Richard Musgrave in 1959, elucidates the function of the government in the economy. Musgrave defines private goods as those that are fulfilled via the market system, based on effective demand. On the other hand, private products may be divided into separate pieces and priced for each individual user. These goods are also accessible for purchase on the market (Yakubu et al., 2021). Some individuals may be barred from using them. This economist contends that public goods would be insufficiently delivered if left to private processes, since the private supplier would inadequately invest in their supply. Paul Samuelson's 1999 Public Good Theory was based on Richard Musgrave's research. Samuelson's argument is that when the market process fails owing to different features of public goods, it is at this point that the government is expected to intervene. The theory outlines the responsibilities of governments in addressing different types of market failure. These include promoting a fair distribution of wealth and maintaining stability in the overall economy by achieving full employment and stable prices. This perspective views the government and its officials as guardians of the public interest, with the ability to maximize social welfare according to the needs of the population (Agha, 2014). An illustrative instance is education, where it is challenging to provide equitable access for all people and prevent some individuals from being excluded from its advantages. Furthermore, it is difficult to quantify the varying degrees of benefit that different citizens get from education. The subject field is relevant to public good theory, since it was specifically developed to satisfy the fundamental needs of individuals in society (Yakubu et al., 2021). The Tertiary Education Trust Fund (TET-fund) is a government fund established to finance the provision of public goods such as classrooms/lecture halls, labs, libraries, dormitories, and academic staff development (Gadanga et al., 2021). Furthermore, the TET-fund involvement in Nigerian universities demonstrates the government's dedication to providing essential resources such as infrastructure development and academic staff training (Bagoro, 2019). The idea is significant because it highlights the need of knowing the educational

requirements at tertiary institutions within the country, as well as the supply of these requirements via TET-fund.

3.0 Research Methodology

Briner & Denyer (2012), believe that a systematic literature review should include several key characteristics. Firstly, it must be systematic, meaning it should be organized in a manner that meets the review questions. Secondly, it should be transparent, with all aspects plainly stated. Thirdly, it should be repeatable, allowing others to replicate the review process. Additionally, it should be updatable, allowing for future revisions and additions. Lastly, it should be synthesized, meaning it should provide a concise summary of the evidence relevant to the review subject. The systematic review followed the approaches provided by Briner & Denyer (2012) and Tranfield et al. (2012). This task involves reviewing the topic, selecting and assessing the studies, analyzing and integrating the research results, and then sharing the findings of the review. The systematic approach offered by research methodology allows readers to analyze the study problem in relation to the defined research objectives (Leedy, 2000, p. 246). The search for Tetfund intervention initiatives studies in Nigeria was undertaken utilizing databases such as Google Scholar and Semantic Scholar. Citation tracking was used to ensure that a significant number of the research studies being analyzed were considered. This report provides a thorough examination of the TETFUND intervention initiatives that have been conducted in the chosen North-Central Universities in Nigeria. This study focuses on the TETFUND intervention initiatives that were carried out in the North-Central Universities from 2020 to 2022. The literature review approach involves the use of relevant, appropriate, and interrelated academic publications to answer the research objectives of the current study, as outlined in Muhammed et al. (2022). The study primarily uses Tranfield et al. (2003) systematic review methodology to highlight the challenges linked to the implementation of BBI. A systematic review has the capacity to enlighten both practical application and academic study by identifying the deficiencies in existing research. A systematic review may assist practitioners in making informed judgments on issue management by providing reliable knowledge from a diverse range of outcomes. A systematic review aids scholars in comprehending the dependability and meticulousness of the research methodology pertaining to the given issue, and acts as a catalyst for generating

fresh research inquiries. The systematic review showcases its depth in two aspects: firstly, by scrutinizing the caliber of the research evidence derived from prior (peer-reviewed) studies, and secondly, by subsequently pinpointing novel and captivating study topics that peer researchers may explore as separate investigations.

4.0 Discussions

Zabbey and Leyira (2019), defines infrastructure as a significant kind of social overhead capital. This includes several essential components such as roads, ports, hospitals, bridges, sewage facilities, airports, power generating and distribution systems, and communication networks. Ibrahim (2017), explains infrastructure to be the fundamental physical and organisational components required for the functioning of a society, system, or company. It encompasses the services and facilities essential for the proper running of institutions such as universities. According to Wapmuk& Amini (2018), infrastructural facilities refer to the physical resources within an educational institution that are used by administrators, academic staff, non-academic staff, and students to ensure the smooth and efficient operation of the institution. These facilities are essential for creating an effective and purposeful teaching and learning environment. Considering its reliance on significant financial resources, Ojukwu et al. (2017) observed that the fundamental infrastructure in Nigerian tertiary institutions, particularly universities, is deteriorating and unable to sustain the rapid increase in student enrollment. The author, however, emphasized that the insufficiency of infrastructure facilities is a significant challenge for the Nigerian educational system. Accordingly, several universities benefitted from the infrastructural largesse owing to the intervention of TETFUND between 2020 and 2022 which includes President Muhammadu Bahari Main Library Complex, Kwara State University, Malete; Performing Arts Theatre, Kwara State University, Malete; Aerial View of the School of Post Graduate Studies, Kwara State University; Academic Building, Federal University of Technology, Minna; Faculty of Natural Sciences Classrooms and Laboratory, University of Jos; The Senate Building, Federal University of Lafia, Nassarawa State; Faculty of Veterinary Medicine Building, University of Jos; 500 Capacity Lecture Theatre, University of Ilorin; The Faculty of Science (Annex Building), Federal University, Lafia; Multi-Media Laboratory, University of Ilorin; and Faculty of Social Science, Federal University, Lafia (see table 1). However, Omubude et

al. (2016), empirically evaluated the TETFUND intervention scheme on the development of infrastructure in the universities. Data were collected using documentary instrument, literature, direct observation and oral interview with relevant officers and staff of the Universities who have direct connection with the TETFUND disbursement and fund utilization in the universities. The study revealed that, research activities have been at a low level in the universities and has led to the decline in the quality of infrastructure, which is visible through lack of modern scientific laboratories. In the same vein, Muhammad (2018), assessed the influence of TETFUND intervention on academic activities in business education departments in Nigeria Colleges of Education through provision of physical infrastructure and instructional materials. The findings showed that TETFUND intervention has not significantly influenced the provision of physical infrastructures in the universities. The researcher concluded that the failure of TETFUND to provide funds for provision of these physical infrastructures, instructional materials constitute the lack of implementation of several intended projects.

Consequently, the considered period has University of Jos, Plateau State with more special projects than zonal projects with a total estimated cost of about ₦3,068,446,165.04 while the University of Ilorin, Kwara State had zonal, special and maintenance intervention at an overall cost of ₦400,000,000 within the period under review. Equally, the University of Abuja, Abuja, FCT largely considered the most versatile university in the country in terms of nature of people or student admitted into the university, and can equally be considered to have the biggest share of the infrastructural intervention project with a whopping sum of ₦2,193,000,000 for the entire special, zonal and annual projects between the reviewed period. Similarly, the Federal University, Lafia, Nasarawa State had only a special project at a sum of ₦1,000,000,000.00 while Federal University of Technology, Minna, Niger State had two projects encompassing the annual, entrepreneurship and special projects at marauding sum of 2,268,710,058.67 (see table 1). Likewise, Federal University Lokoja, Kogi State had annual, entrepreneurship and project maintenance within the period under review for an overall sum of ₦2,173,710,058.67. Furthermore, Federal University of Health Sciences, Otukpo, Benue State had annual and special projects that gulped the sum of ₦1,137,444,087.51 while Joseph Sarwuan Tarka University, Makurdi, Benue State had just a

maintenance project that with a sum of ₦70,600,000.00 for the period under review. These show that while the effectiveness of these project are inherent in the outcome of the performances of the students in terms of research outcomes (Abdullahi, 2021), more admission of students into the high institution (Omosidi et al., 2023), conducive learning environment (Yakubu et al., 2021; Gadanga et al., 2021), increment in the number of graduating students (Adavbiele, 2016) and better ranking of the Nigerian Universities within and outside Africa (Hamisu & Musa, 2015; Oraka et al., 2017). As a result of the continued need for investment in the educational sector of Nigeria, Echono (2023), indicates that N3 billion is granted to six chosen varsities, N1billion each to six polytechnics and six colleges of education throughout the nation, while over 95 per cent of the N320 billion total TETFUND's distribution of 2023 will go straight to recipient tertiary institutions. Five percent of the budget will be allocated for staff wages and allowances, project monitoring, and zone capital projects. According to him, 62 percent of the total disbursement, amounting to N198 billion, consisted of the institutions' annual direct disbursement. Additionally, 20 percent of the disbursement, equivalent to N64.2 billion, would be allocated for special disbursement. These funds are obtained from a 2 percent assessable profit of Limited Liability Companies and special grants, such as The Need Assessment Project, Central Bank, Universal Provision Fund by NCC, and other donor agencies. These sources of revenue complement the interventions provided by TETFUND.

Table 1: Implemented TETFUND Infrastructural Projects (2020 – 2022)

YEAR	INSTITUTIONS	PROJECTS	INTERVENTION TYPE	AMOUNT
2021	University of Jos, Plateau State	Construction of Security Gate House for Faculty of Agriculture	Zonal	129,073,531.68
		Construction of External Works/Landscaping of Faculty of Social Science.		56,487,806.00
		Establishment of Tissue Typing Centre and Upgrading of Renal Dialysis Facility.	Special	498,501,898.24
2022		Construction of Perimeter Fence with overall length of 860M consisting of precast concrete and block work- Lot I.	Special	249,913,774.75

		Construction of Mobile Police Post, Unlined Earth drains, Observation tower and 110M Fence - Lot II.	Special	201,499,149.23
		of Security Gate House and 750M Long Fence Work - Lot III.	Special	227,399,999.39
		Construction and Furnishing of two storey Lecture hall and Laboratory Building for Faculty of Pharmacy	Special	455,570,005.75
		Construction and Furnishing of Deanery Building for Faculty of Veterinary Medicine	Special	1,250,000,000.00
		Construction and Furnishing of Department Office Building for Faculty of Agriculture		
2020	University of Ilorin, Kwara State	Procurement Installation, Testing and Commissioning of Laboratory Equipment for Teaching and Research for College of Health Sciences	Special	150,000,000.00
		Procurement Installation, Testing and Commissioning of Laboratory Equipment for Teaching and Research for the Faculties of Non-Medical Sciences		
		Procurement, Installation, Testing and Commissioning of Laboratory Equipment for Teaching and Research for the Faculty of Sciences		
		Supply, Installation, Testing and Commissioning of Laboratory Equipment for Department of Electrical & Electronics Engineering and Chemical Engineering	Zonal	200,000,000.00
		Supply and Installation of Furniture for Medical Biochemistry Laboratory		
2020 - 2022		Renovation/Rehabilitation of Life Science Building Phase (V)		

		Renovation/Rehabilitation of Multipurpose Hall.	Project Maintenance	50,000,000.0
		Renovation/Rehabilitation of Materials and Metallurgical Engineering Workshop.		
2020	University of Abuja, Abuja, FCT	Construction of One Storey Female Student's Hostel	Special	825,000,000.00
		Construction of One Storey Male Student's Hostel		
		Construction of External Work and Furnishing of Female Hostel		
		Construction of External Work and Furnishing of Female Hostel		
		Construction of External work and Furnishing of Male Hostel		
2020		Construction of One storey Building for central Research Laboratory (Zoonoticts and Infectious Diseases Laboratory) Phase I	Annual	278,000,000.00
		Construction and Furnishing of Bungalow Building for University Health Centre	Zonal	
2021		Upgrade of Urology and Renal Transplant Facility comprising; Rehabilitation of Urology Theatre, Supply, Installation, Testing and Commissioning of Equipment	Special	500,000,000.00
		Establishment of Organ Transplant Tissue Typing Facility comprising; Remodeling of Tissue Typing Laboratory Space, Supply, Installation, Testing and Commissioning of Equipment		
2021		Supply, Installation Testing and Commissioning of Veterinary Teaching Hospital and ICT Equipment	Zonal	200,000,000.00
		Supply, Installation, Testing and Commissioning of Academic Support Equipment		

2021		Construction and Furnishing of Faculty of Health Sciences Phase 1 comprising: Provost Offices, Dean's Offices, General Offices, Boardrooms, Ancillary Spaces. Furnishing	Annual	390,000,000.00
		External Infrastructure and Landscaping comprising: Parking, Landscaping works Including 255m2 Interlocking Tiles Paving, 1Nr 7500L		
2021	Federal University, Lafia, Nasarawa State	Construction and Furnishing of 26-Rooms Capacity Male Hostel Building (all ensuite).	Special	1,000,000,000.00
2021	Federal University of Technology, Minna, Niger State	Construction of 500m Road Network to Access the Completed School of Life Sciences and School of Physical Science at Gidan Kwano Campus Phase II	Annual	390,000,000.00
		Additional Project: Supply, Installation, Testing and Commissioning		
		Construction and Furnishing of Student hostel comprising: 38nr rooms en-suite	Special	500,000,000.00
		Renovation of Electronic Testing Centre	Project Maintenance	
2019/2020/2021/2022		Construction of Machine shed water tank base for Entrepreneurship Centre	Entrepreneurship	23,710,058.67
		Construction and Furnishing of Central Workshop	Special	1,000,000,000.00
		Construction, Furnishing and Procurement of equipment Foundry	Annual	355,000,000.00
2021		Construction and Furnishing of School of Engineering Building (Phase I)	Annual	390,000,000.00
		Construction of Senate Building		1,725,000,000

2021/2022	Federal University, Lokoja Kogi State	with 3Nr Suspended Floors		.00
		Procurement, Installation, Testing and Commissioning of Various Equipment for Entrepreneurship Skill Training	Entrepreneurship	23,710,058.67
		Renovation of ICT and Library Building at Felele Campus Comprising the following items of Work: Demolishing Work, Roof Covering and Ceiling Repair, Windows and Doors Replacement, Finishes, Electrical and Mechanical Work, etc.	Project Maintenance	35,000,000.00
2021	Federal University of Health Sciences, Otukpo, Benue State	Construction and Furnishing of One (1) Block of Classroom, Laboratory and Offices for the Department of Arts	Annual	275,353,612.29
		Procurement Installation, Testing and Commissioning of Laboratory Equipment for Biochemistry College of Medicine		
		Procurement Installation, Testing and Commissioning of Laboratory Equipment for Physiology College of Medicine		
2022		Construction of Hostel with 2Nr Suspended Floors	Special	782,444,087.41
		Construction of Hostel with 2Nr Suspended Floors		
		Procurement of 2Nr Operational Vehicles	Annual	79,646,387.81
		ADDITIONAL PROJECT: Supply and Installation of 3Nr HP Pavilion		
	Joseph Sarwuan Tarka University, Makurdi, Benue State	Renovation of Administrative/ Office Building.	Project Maintenance	70,600,000.00
		Renovation of Bursary Building (Administrative Building		

		Annex).		
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Source: TETFUND Department of Physical Infrastructure, (2023)

5.0 Conclusion and Recommendations

This study that reviewed the various TETFUND intervention projects implemented in federal universities of the North-Central Nigeria (2021 – 2023) concludes that despite the increment in the performances of the TETFUND in the area of financial disbursement to the various North-Central Universities, more financial inducement leading to more infrastructural development of these universities are required triggering the need for a possible rise in the financial tax of the companies and donor agencies that provide finances to TETFUND. Hence, the implementation of projects has a direct impact on the development of infrastructure in universities. This means that when universities are established, they must receive sufficient funding and necessary infrastructure to support the academic activities of students, management, and staff. Thanks to the efforts of TETFUND, it has become one of the most well-organized intervention programmes in Nigeria since independence. It has successfully unified and enhanced the infrastructure in Nigerian universities. Based on this achievement, the federal government should provide further support and authority to TETFUND to address the challenges faced by the university system. Consequently, the following recommendations are inherent from the findings of this study;

1. This study proposes raising the assessable profit of TETFUND from 2% to a minimum of 5%. This increase is necessary to guarantee the independence of TETFUND and enable it to sustain its intervention efforts aimed at enhancing the quality and standards of structural facilities in the Nigerian university system. Consequently, this would lead to a significant transformation of the overall university infrastructure and the development of the Nigerian university system as a whole.
2. TETFUND shall ensure the provision of their services to universities in a comprehensive manner, with the aim of assisting them in rejuvenating their deteriorated and struggling infrastructure facilities.
3. The government and TETFUND authorities must guarantee that universities effectively use the granted cash to construct their infrastructure.

4. The government should establish a process to guarantee that funds allocated to universities are used for their intended purposes.
5. TETFUND should be permitted to persist in its intervention efforts to enhance the calibre and excellence of structural amenities within the university system. This would consequently guarantee the vital transformation of the entire university infrastructure and subsequently foster the advancement of the university system.
6. TETFUND should establish a specific timeframe for the completion of projects at recipient institutions in order to address the issue of incomplete and abandoned projects. This is advised due to a limited number of instances of non-completion, subpar quality of some projects, and delays in completion, among other reasons. It is advisable to establish a local fund management committee for the beneficiary institution in order to oversee the ongoing building project. The committee's report should be given due consideration and handled with utmost importance by the management of TETFUND intervention.

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VOCATIONAL AND TECHNICAL EDUCATION: A SOLUTION TO UNEMPLOYMENT AMONG GRADUATES IN NIGERIA

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ABSTRACT

This study is designed to examine vocational and technical education among youth unemployment, mostly graduates in Nigeria as well as the causes and implications. Graduates are very important stakeholder in any society. They are not only the future hope of Nigeria, but also a major stakeholder and very useful resource in nation building. However, available information indicates that Graduates unemployment is very common in Nigeria with far reaching implications for stability of the economy. Unemployment has a negative multiplier effect not only on the individual involved but on the nation as a whole. This study identified some causes of Graduates unemployment in Nigeria such as, negative impression on technical and vocational education, total neglect of the agricultural sector, poor educational planning and poor enabling environment. Graduates unemployment has been identified as one of the core causes of the rising level of social disorder and insecurity permeating the entire country of Nigeria. This paper therefore concludes that addressing the problem of Graduate unemployment must involve all the stakeholders and that effective policy means uses such as re-priorization of the Agriculture sector, reformation of education system and provision of enabling Environment that will drastically reduce unemployment and poverty should be adopted to eradicate the menace of Graduates joblessness.

Keywords: Vocational, Technical Education, Unemployment, Nigeria.

INTRODUCTION

Nigeria's Gross Domestic product (GDP) growth rate according to the National Bureau of Statistics (NBS 2024') is estimated at 2.98% as at first quarter of 2024. The country's population growth rate is 2.5 percent, while high level of infrastructure deficits and limited employment growth are major constraints to socioeconomic development of Nigeria's population for more than a decade due to these constraints. The Nigerian economy is growing without appreciable employment opportunities for its teeming population, which has serious socioeconomic consequence. The growth in crude oil revenue in Nigeria is accompanied by relatively limited employment growth, and deteriorating education standard. Graduates are intelligent and creative people with the ability to think critically (Fanimu & Okeke, 2019) and who compete for job in the domestic and global labor-market places.

Graduate unemployment imposes socioeconomic costs; it is a waste of man power resources, the investment in education and training is unused. This study defines graduate unemployment to include graduates of universities and polytechnics who are capable and willing to work but could not find a job or are discriminated for lack of experience.

Merricum web ster's collegiate dictionary defines unemployment as the state of not being engaged in a gainful occupation. This can be measured by the proportion of labour force that were available for work but did not work.

Unemployment has become a major problem bedeviling the lives of Nigerian youth, causing increased militancy, violent crimes, kidnappings, restiveness and socially delinquent behavior.

Youth unemployment is deviating to the individual and the society as a whole both psychologically and economically. Youth unemployment is really troublesome issue in many parts of the world Nigeria inclusive. In Nigeria, it has become one of the most serious socioeconomic problems confronting the country. The magnitude of this can be appreciated if accurate statistic could be obtained from the Federal Bureau of statistic on the number of unemployed youths roaming the streets of Nigerian cities. Ashinumese (2021) observed from the excerpts of statistics showed that Nigeria has a youth population of eighty (80) million representing 60 percent of the total population of the country. Sixty four (64) million of them are unemployed while one million six hundred thousand (1.6 million) are underemployed.

Unemployment or the search for paid employment in Nigeria has become endemic. This is support by the claims that Nigerian education system is bookish and academic oriented and lacked vocational and entrepreneurial values. The prevalence of unemployment in Nigeria remains a great challenge confronting the government and the people today. This calls for scholars of various disciplines of learning to brainstorm on how best our educational system and methodology can begin to yield result in curbing this menace. Vocational and Business education has been carefully designed to meet basic skills, knowledge and capabilities to function either as a vocational or business teacher or executive. According to Oluba (2020) Business education is an aspect of education program which prepares students for careers in business. It is education needed to teach people business, education needed to handle personal affairs and education needed about business in order to be good citizens of a society.

Indeed the gains and good score cards of Business and vocations education, Youths have continued to grapple with unemployment in Nigeria. Bankole (2022) asserts that the harsh economic realities in the country today, notwithstanding upcoming generations of graduates when given proper orientation and entrepreneurial education can become successful here in Nigeria. Entrepreneurship education is the programme designed to inculcate the knowledge, skills and mindset needed to conceived and start your own business.

THE MEANING OF ENTREPRENEURSHIP EDUCATION:-

Entrepreneurship education as defined by the consortium for entrepreneurship education is a form of education that seeks to prepare people especially youths to be responsible enterprising individuals who become entrepreneurs and entrepreneurial thinkers and who contribute to economic development and sustainable communities. It is not based on textbook course, rather students are immersed in real life learning experiences where one have an opportunity to take risk, manage the results and learn from the outcomes.

Godwin and Johnson (2018) defined entrepreneurship education as that form of education which inculcates into the individual learner concepts, skills and knowledge on how to start a new business, create jobs, create business ideas, develop the business, Entrepreneurial studies are inter-disciplinary training that focuses on the tools needed to start a new business or vocation. Because Nigeria is fast becoming a predominantly youthful society with high rate of unemployment requires training the youth in entrepreneurial skills in Technical vocational Education and Training to tackle the unemployment which has reached alarming proportions. This is because the youth represents a tremendous potentials development of human capital which the society cannot afford to neglect.

Many youth face high unemployment, joblessness and difficulties in getting a firm foothold into the labour market. These have led to problem of unemployment especially among youth leaving various educational institutions. The youth graduate from school without the needed skills or competencies that would enables them function in today's emerging society. Manage it and make profit.

Technical and vocational Education: Technical and vocation education (TVE) has been an integral part of national development strategies in many societies because of its impact on productivity and economic development.

Despite its contributions the leaders of Nigeria have not given this aspect of education the attention it deserves. And that is one of the reasons for the nation's underdevelopment.

Vocational education and training, prepares learners for careers that are based in manual or practical activities, traditionally non-academic and totally related to a specific trade, occupation or vocation. In other words, it is an education designed to develop occupational skills, vocational and technical education gives individuals the skills to live, learn and work as a productive citizen in a global society. The United States is not the only society that appreciates skills acquired through vocational and technical education. The Dutch school system is said to pay attention to high standards in mathematics and the provision of vocation education at aged 14-16 for a third of all pupils, and widespread vocational education at 16 +. And secondary (high) schools in much other development – conscious nations have vocational centers that offer vocational training for lifelong trade together with general academic studies. For instance, India and the Asian Tigers' could not have become what they are without massive investment in technical education.

However, because of recent changes in world economy many vocational and technical schools have shifted emphasis to training in the computers and information technology.

Dike (2019) defined TVET as a form of education that primarily concern the development of occupational skills needed in an individual as a preparation for work. It is a form of education which promotes the dignity of labour by entraining work as the goal of education.

Causes of Graduate unemployment:-

Economic recession and government policy can cause unemployment.

According to Keynes, (1936), the level of employment in a modern economy was determined by three factors; the marginal propensity to consume (income that people chose to spend on goods and services the marginal efficiency of capital (the rate used to see whether investment are worthy), and the rate of interest. The distortions in the economy, instability of prices, inflation, deflation, unemployment and the fluctuations in economy activity giving rise to it, could be restored by government involvement and spending.

The World Bank (2012) links high youth unemployment in sub-sahara Africa particularly to poorly conceptualized, inadequate, and ill-delivered technical and vocational education and training. Some countries implement measures to promote and support self-employment in

their technical and vocation education training. Canada, U.S.A, Portugal, South Korea, Finland and Spain are good examples.

CONCLUSION

The paper conclude that vocational and technical education a solution among graduate in Nigeria education agenda and how the integration of both area of study can create a synergy for dealing with the issue of unemployment. Unemployment among young graduates in Nigeria has become endemic and therefore requires a combination therapy. Youth unemployment can be tackled.

Every young person could be given the chance that previous generations took for granted.

Together we can help the young people get the jobs on which their future and those yetunborn depends. This can be achieved through entrepreneurship training in Technical vocational Education and Training.

RECOMMENDATIONS:

The following recommendations are made

- (1) Addressing the graduate's unemployment in Nigeria requires an integrated holistic approach. Shortcuts will not work. The World Bank 2003 report advocates for a comprehensive model that cater for rural development, rural-urban migration, preparation of young people for the labour market and investments in agriculture.
- (2) The aim of every government should be to create enabling environment to promote investments. This includes provision of power, maintaining law and order, and adequate security. The justice system must also be strong to facilitate strong contracts and protect mutual trust.
- (3) Education Curriculum must be immediately revised to incorporate skills and enterprise development. A special program should be designed for low-skilled youth in vocational centers. Incentives should be provided to SMEs that promote student internship.
- (4) Agriculture is a viable source of investment for youths if it is made attractive. There should be a swift transition from subsistence to commercialize farming.

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EFFECT OF CONSTRUCTION MATERIAL WASTAGES ON COST OVERRUN OF BUILDING PROJECTS IN NIGER STATE, NIGERIA: A LITERATURE REVIEW

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ABSTRACT

A significant percentage of the construction materials delivered to project sites end-up as waste, and this often results in additional project cost. Project cost overrun is a prevalent problem in developed and developing nations, hindering many projects from being completed within pre-planned budget. These overruns result from various sources, the interplay of which are crucial to understand in order to enhance the cost efficiency of construction project delivery. Various studies have examined different factors that contribute to construction cost overruns and material wastages, nonetheless, these studies failed to give a clear indication on the relationship existing between material waste and cost overrun. This study fills the existing gap by adopting a literature review methodology to evaluate and critique various sources of material wastages and their consequential cost overruns in order to establish a nexus between them. Findings from extant literature revealed existence of a relationship between material waste and cost overrun. Thus, an increase in material waste would result to a corresponding increase in the amount of cost overrun at both the pre-contract and the post contract stages of a project. In conclusion, this research makes a novel contribution by achieving an effective construction material waste management system through quality-construction planning, quality material estimating, quality design management, quality procurement management and quality site operations management, and a decrease in design complexity as this would consequently lead to a reduction in material wastages and cost overrun.

Key Words: Construction, materials, waste, building project

Introduction

The construction sector is one of many sectors that contribute to a country's socioeconomic development. The industry's development is crucial for the socio-economic progress of a country and directly contributes to economic growth (Hailemariam, 2021). The building industry has made a significant contribution to the nation's gross domestic product (GDP). In

Kenya, it accounted for around 7%, in Nigeria 11.9%, and on average for Sub-Saharan Africa it was 21.3%. (Gashahun, 2020). Adenaiya and Adejugbagbe (2020) stated that materials are essential resources needed for constructing physical infrastructure. He states that materials account for around 51% of construction costs, emphasising the significance of using high-quality materials and effectively managing waste in building projects. The materials include of metal reinforcement, bricks, mortars, masonry, lumber, steels (common and stainless), polymers, composite fibers, green materials, and recycled materials (Ogawa et al., 2019).

Material wastage is a significant issue in the global building and construction sector (Tongo et al., 2021). Wu et al. (2019) reported that the worldwide yearly production of Construction Waste exceeds 10 billion tonnes, with the United States generating around 700 million tonnes and the European Union creating over 800 million tonnes. Construction waste has become the greatest waste stream globally when compared to other waste streams. Waste in building construction has several interpretations among individuals. Various professionals in the building construction industry and academia have discussed and defined it. Zheng et al. (2017) described wastes from building and construction-related activities as a diverse range of inert and organic materials resulting from construction activities.

Construction cost overrun is a prevalent problem in industrialised and developing nations, hindering many projects from being finished within budget. Albtoush and Doh (2019) emphasised that 90% of projects in the construction projects experience cost overruns often ranging from 50% to 100%. Studies on construction projects in certain developing nations show that the final cost often surpasses the initial contract price by approximately 30% (Oynaka, 2020). These overruns result from various causes, the interplay of which are crucial to understand in order to enhance the cost efficiency of construction projects.

Construction Waste presents a significant environmental problem during all phases of a construction project, including raw material extraction, processing, production, shipping, construction, and trash management after demolition. Global building material waste production has exceeded 3 billion tonnes, with India, China, and the USA accounting for over 2 billion tonnes (Akhtar and Sarmah 2018). Poor management of materials at a construction site can lead to increased costs due to wastage, compromised quality, and

delays, ultimately affecting project completion. Mahamid (2020) asserted that material wastages are highly associated with causing project cost overruns. Recent reports from the Construction Industry Research and Information Association (CIRIA, 2021) have emphasised the worldwide significance of material waste, indicating a need for localised studies to tackle region-specific concerns. In Nigeria, there is a paucity of comprehensive research that specifically examine the relationships between building material waste and cost overruns in construction projects. There is a lack of awareness of how material waste affects construction project budgets in the Nigeria, despite the important economic consequences of cost overruns. consequently, an in-depth investigation on the impact of building material waste on cost overruns is necessary to fill this research gap. On this basis, this research seeks to examine the relationship between construction material wastages and cost overrun of building projects.

2. Research Methodology

The research adopts the desk top methodological approach. This involves comparing the causes of material waste and those of cost overruns from the review of the related literature in order to determine their possible relationship. The relevant secondary source of data for this research include: published materials (books, journals) and unpublished reports, such as: periodicals, conference proceedings, and guidelines relating to material waste and cost overruns in the construction industry. The analysis was performed by comparing the causes of material waste and those of cost overrun identified from the literature.

3.0 Results and Discussion

3.1 Relationship Between Material Waste and Construction Cost Overrun

Construction waste is commonly categorised into physical waste, which consists of actual rubbish produced during building, and non-physical waste, which encompasses indirect wastes such as time and cost overruns (Birkle et al., 2020).

Material waste is the main kind of physical waste produced by construction activities, these including bricks, wood, and concrete (Birkle et al., 2020). Material waste has been

demonstrated to have adverse effects on both costs and the environment. Illegal dumping is a consequence of the substantial volume of material waste produced and its poor management. This is an act of unlawfully disposing of garbage on land. It is a globally detrimental activity that results in significant environmental issues. Illegal dumping of physical waste on land is on the rise, contributing to global pollution according to Sweis et al. (2021). It is crucial to analyse the present situation by pinpointing the underlying reasons for waste in construction to prevent adverse consequences.

Conversely, waste might be categorised as non-value-adding activities (Sweis et al., 2021). The term "non-value adding activity" is used to differentiate between physical waste and other types of waste that occur during construction activities (Manoharan et al., 2021). It is also referred to as immaterial waste. A research by Ayfokru et al. (2023) defined non-physical waste as activities that consume resources without adding value, including errors necessitating corrections, overproduction, excessive processing, waiting for other operations, and superfluous motions. These activities necessitate more time and financial resources, leading to the failure of many building projects. Nonphysical waste has a substantial impact on the economic growth and social development of countries (Manoharan et al., 2021).

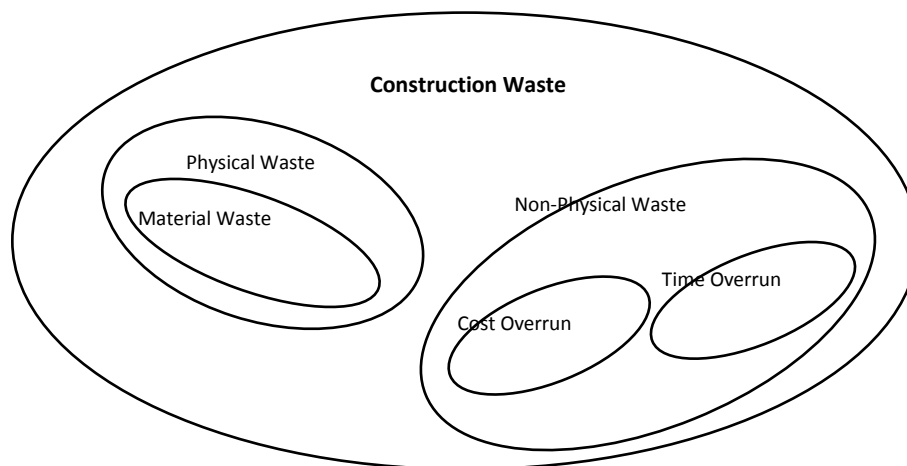


Figure 3.1: construction waste Classification

Source:Birkle et al. (2020)

3.2 Summary of the Relationship Between the Cause of Material Waste and Cost Overruns at Design, Procurement, and Construction Stage.

Stages	Causes of material waste similar to the causes of cost overruns	Impact	References
Design	<ul style="list-style-type: none"> -Change in client requirements. -Complex design. -Design changes. -Design Errors. -Communication problems. -Insufficient design quality and quality control. -Lack of necessary design information 	<p>Raising expenses resulting from alterations, rework and additional processing, result in material waste that can be discarded.</p>	<p>Muzaffar et al. (2022); Sweis et al. (2021); Carvajal-Arango et al. (2019)</p>
Procurement	<ul style="list-style-type: none"> -Waste from packaging. -Mistakes in quantity. - Limited early coordination among parties during design. -Suppliers' error. -Purchased goods do not agree with the requirements. 	<p>Additional resources due to bad procurement processes result in wastage, causing economic and environmental consequences.</p>	<p>Ayfokru et al. (2023); Muzaffar et al. (2022); Sweis et al. (2021); Kabirifar et al. (2020)</p>
Construction	<ul style="list-style-type: none"> -Overtime. -Time stress. -Workers errors. -Lack of training. -Leftover materials. -Using the wrong materials. 	<p>The construction stage involves several activities and processes that if not well manage result in insufficient use of</p>	<p>Ayfokru et al. (2023); Muzaffar et al. (2022) Muzaffar et al. (2022); Sweis et al. (2021);</p>

-Poor supervision.	resources, leading	Manoharan et al.
-Poor experience and knowledge.	to extra cost.	(2021);
-Inadequate storage methods.	(economic and	Carvajal-Arango
-Inaccessible project location	environmental	et al. (2019)
-Governmental issues.	effects).	
-Stealing issues		
-Weather		

Source: Author's Review, (2024).

4.0 Conclusion and Recommendations

It has been established from this research that a relationship exists between material waste and cost overruns at various stages of a project. This implies that an increase in material wastage on site leads to a corresponding increase in cost overruns, regardless of the percentage allowed for material waste in the process of the bill preparation. In conclusion, this research makes a novel contribution by achieving an effective construction material waste management system through quality-construction planning, quality material estimating, quality design management, quality procurement management and quality site operations management, and a decrease in design complexity as this would consequently lead to a reduction in material wastages and cost overrun.

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INVESTIGATING EXPORT-LED GROWTH HYPOTHESIS: A COMPARISON OF TWO COINTEGRATION MODELS

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ABSTRACT

The study investigated the Export-Led Growth Hypothesis in Nigeria using two cointegration models - Engle-Granger cointegration and error correction model, and the autoregressive distributed lag (ARDL) approach. Quarterly time series data from 1988 to 2022 was analyzed, including variables like Gross Domestic Product (GDP), exports, imports, gross fixed capital formation, and labor force. The cointegration tests revealed a long-run relationship among the variables, and the long-run coefficients from the ARDL model suggested that exports and labor are significant predictors of GDP changes at the 1% level. The stability of the models was confirmed through CUSUM recursive tests. Comparing the results, the ARDL approach was found to be more consistent with the Toda-Yamamoto Granger causality analysis, which revealed a bidirectional causality between GDP and exports, thus confirming the validity of the Export-Led Growth hypothesis in Nigeria. The study recommends that statisticians and econometricians should be encouraged to use the ARDL model, as the Engle-Granger approach can lead to misleading conclusions. The findings highlight the importance of exports and labor in driving economic growth in Nigeria and provide valuable insights for policymakers to design effective strategies to promote export-led growth.

Keywords: Export-Led Growth, Cointegration, ARDL Model, Granger Causality, Nigeria

BACKGROUND TO THE STUDY

Economic growth means an increase in the productive capacity of an economy over time to bringing about rising levels of national production and income (Sheehan *et al.*, 2019). Every country (developed and the developing) is concerned about its rate of economic growth. Economic experts, policymakers, public, and private sectors work ceaselessly towards attaining economic growth by the use of development models and policies. In this study, the export-led growth in Nigeria is examined.

According to export-led growth strategists, the growth of an emerging nation is largely dependent on the capacity of the nation to produce goods and services in which they have comparative advantage for its local needs and ultimately for export, and import the commodities in which they have comparative disadvantage, i.e. high internal opportunity cost (Nduka, Chukwu, Ugor&Nwakaire, 2018). In affirming the relevance of international trade in Africa, Kofi Annan, the former UN Secretary General said, "Africa's growth out of

poverty will depend on its developing greater linkages with the world economy through trade.”

Aim and Objectives of the Study

The aim of the study is to Investigate Export-Led Hypothesis by comparing two co-integration models.

The specific objectives of the study are to:

1. Examine the relationship between export, import, labour, capital and gross domestic product
2. Identify the changes in GDP that can be attributed to export, import, labour and capital
3. Examine the robustness between Engle-Grangers model and autoregressive distributed lag (ARDL) model in the study of export-led growth on Nigeria.

LITERATURE REVIEW

The Effects of Export on Economic Growth

In the last decade, there has been a surprising and impressive resumption of activity in the economic growth literature triggered by the endogenous growth theory, which has led to an extensive inventory of models that stressed the importance of trade in achieving a sustainable rate of economic growth. These models have focused on different variables such as the degree of openness, exchange rate, tariffs, terms of trade and export performance, to verify the hypothesis that open economies grow faster than closed ones (Edwards, 2019).

The Empirical Literature Review on Export-Led Growth Hypothesis in Nigeria

In Nigeria, some authors had examined the performance of foreign trade and economic growth. For instance, Egwaikhide (2021) examines the qualitative effects of export (non-oil) expansion on Nigeria’s economic growth over the period, 1960 to 1983. Based on simulation experiment, he observes among others, that a 75 per cent rise in non-oil export led to 1.4 per

cent increase in real GDP. He concluded that there is need to promote export in order to enhance GDP growth in Nigeria.

Ogbokor (2017) investigated the macroeconomic impact of oil exports on the economy of Nigeria. Utilizing the popular OLS technique, he observed that economic growth reacted in a predictable fashion to changes in the regressors used in the study. He also found that a 10% increase in oil exports would lead to 5.2% jump in economic growth. He concluded that export oriented strategies should be given a more practical support.

Olusegun (2019) examines the export-led growth hypothesis for the period, (1970-2006), he uses five important variables, GDP, export value, import value, exchange rate, labour force and gross capital formation. He investigated both causal and dynamic long run nature of the variables using ARDL and Toda-Yamamoto causality test. The findings showed that there is a bidirectional relationship between output and export hence, a support for export-led growth for Nigeria.

The Analytical Framework

We base our empirical model on the Feder (2021) model. Starting with a general neoclassical Aggregate Production Function:

$$Y_t = A_t K_t^\alpha L_t^\beta$$

where, Y_t = aggregate production of the economy at time t , A_t = level of Total Factor Productivity (TFP), K_t = capital stock at time t , L_t = stock of labour at time t . According to Feder (2021) the impact of exports on economic growth possibly operates through total factor productivity (A_t). In order to investigate if and how exports affect economic growth through changes in TFP, we assume that TFP can be expressed as a function of exports X_t , and other exogenous factors C_t , thus:

Engle Grangers Cointegration and Error Correction Approach

The link between cointegration and error correction model stems from the Granger representation theorem (Engle and Granger, 2017). The theorem states that two or more integrated time series that are cointegrated have an error correction representation, and two or more time series that are error correcting are cointegrated.

The Autoregressive Distributed Lag (ARDL) Cointegration Approach

Following Pesaran *et al.*, (2021) as summarized in Choonget *et al.*, (2015), we apply the bounds test procedure by modeling equation (2.4) as general vector autoregressive (VAR) model of order p in z_t :

$$z_t = c_0 + \alpha t + \sum_{i=1}^p \eta_i z_{t-i} + \varepsilon_t, t=1, 2, 3 \dots T \quad (2.8)$$

With c_0 representing a $(k+1)$ -vector of intercepts and α denoting a $(k+1)$ -vector of trend coefficients, z_t is the vector of variables y_t and x_t respectively. y_t is the dependent variable defined as LY_t , and x_t is the vector matrix which represent a set of explanatory variables (as already defined) with a multivariate independently and identically distributed (*iid*) zero mean error vector $\varepsilon_t = (\varepsilon_{1t}, \varepsilon'_{2t})'$ and a homoscedastic process.

METHODOLOGY

Data on GDP (Y_t), exports (X_t), oil exports (OX_t), imports (M_t), total labourforce (L_t) and Gross fixed capital formation (K_t) for Nigeria were used for the study periods 1988 - 2022. The following will be followed, first, since both cointegration test and Toda-Yamamoto Granger Causality test require certain stochastic structure of the time series, stationary properties of the time series data was investigated using the Phillips Perron (PP) tests in order to determine the order of integration of each time series.

Model Specification

In order to estimate the Export-led growth variable by the Engle-Granger Cointegration, the first step suggested by Engle and Granger (2017) in cointegration test was to subject the time

series individually to unit root tests. This research employed the method of Phillip Perron (PP) test. The following model will be estimated if the variables in the equation are integrated of the order using ordinary least square method, which is:

$$LY = \beta_0 + \beta_1 \ln X_t + \beta_2 \ln M_t + \beta_3 \ln L_t + \beta_4 \ln K_t + \varepsilon_t$$

Where, \ln : natural log, $[Y_t]$: gross domestic product $[X_t]$: exports, $[M_t]$: imports, $[L_t]$: Labour force and $[K_t]$: capital and $[\beta_0, \beta_1, \beta_2, \beta_3, \text{and } \beta_4]$ are the parameters known as the intercept and slope coefficients, and $[\varepsilon_t]$ is the random disturbance terms. A long-run relationship is established, if linear combination of these variables in their levels produces a residual variable that is integrated of order zero. Then, cointegration is established and the model is estimated using the error correction model as given below

$$\Delta \ln Y = \beta_0 + \beta_1 \Delta \ln X_t + \beta_2 \Delta \ln M_t + \beta_3 \Delta \ln L_t + \beta_4 \Delta \ln K_t + \varepsilon_{t-1} + u_t$$

DATA ANALYSIS

In this section, empirical analysis of export-led growth for the quarterly data between periods 1988 to 2022 was carried out explicitly. An in-depth analyses and explanations to this period were given as follows.

Unit Root Test Results

In order to perform Johansen Cointegration test, the series have to be stationary. To investigate whether a series is stationary or not, unit root test was conducted using Phillips-Perron test statistic at level and at first difference of each series on the condition that the null hypothesis is non-stationary, so rejection of the unit root hypothesis supports stationarity.

The hypothesis tested is:

$H_0: [\gamma = 1]$ (unit root is present)

$H_1: [\gamma \neq 1]$ (unit root is not present)

$[\alpha = 0.05]$

Test statistic

$$\tilde{t} = \frac{S}{S_{Tm}^2} \hat{t}_p - \frac{0.5(S_{Tm}^2 - S^2)T}{S_{Tm} \sqrt{\sum_{t=2}^T y_{t-1}^2}}$$

Critical region: Reject H_0 if, p-value < 0.05 for rejection of hypothesis of a unit root at 5% significance level

Table 4.2: Results of Phillips-Perron Test at Level (Intercept but no trend)

Variables	Test	Critical	P-Value	Decision
	Statistics	Value (5%)		(order of integration)
lnY	-0.406039	-2.951125	0.8971	I(0)
lnX	-1.295222	-2.951125	0.6204	I(0)
lnM	-0.645356	-2.951125	0.8471	I(0)
lnL	0.709893	-2.951125	0.9906	I(0)
lnK	1.053112	-2.951125	0.9962	I(0)

ln: natural log, Y: gross domestic product, X: export, M: import L: labour K: gross fixed capital formation.

Table 4.3: Results of Phillips-Perron Test at First Difference

(Intercept but no trend)

Variables	Test	Critical	P-Value	Decision
	Statistics	Value (5%)		(order of integration)
D(lnY)	-5.346198	-2.954021	0.0001	I(1)
D(lnX)	-6.959399	-2.954021	0.0001	I(1)

D(lnM)	-5.000943	-2.954021	0.0003	I(1)
D(lnL)	-4.568404	-2.954021	0.0009	I(1)
D(lnK)	-4.958945	-2.954021	0.0003	I(1)

D: first difference **L:** natural log, **Y:** gross domestic product, **X:** exports, **M:** imports, **L:** labour **K:** gross fixed capital formation.

Conclusion: Table 4.2 and 4.3 showed the results of unit root test. The results revealed that time series were non-stationary at levels. However, table 4.3 indicated that the series became stationary at 1st difference [I(1)]. Phillips-Perron unit root test revealed that errors had constant variance and were statistically independent. Therefore, cointegration test can be applied on these variables, as supported by Shahzadi and Chohan, (2021).

Determination of Lag Length

The determination of lag length is a trade-off between the curses of dimensionality and abbreviates models, which are not appropriate to indicate the dynamic adjustment.

If the lag length is too short, autocorrelation of the error terms could lead to apparently significant and inefficient estimators. Therefore, one would receive wrong results.

Table 4.4: VAR Lag Selection Criteria by Schwarz Information Criterion

Number of lag	lnY	lnX	lnM	lnL	lnK	system
Lag 1	-0.007	1.416	0.905	-4.497	0.538	-4.558
Lag 2	0.070	1.352	0.852	-4.031	0.832	-3.148
Lag 3	0.327	1.621	1.082	-3.675	1.098	-2.707
Lag 4	0.415	1.931	1.295	-4.315	1.404	-2.666

Table 4.4 above reported the optimal lag length of one (i.e $p=1$) out of a maximum of 4 lag lengths considered.

Cointegration Test

Cointegration tests were performed using Engle-Granger approach and autoregressive distributed lag (ADRL) bound test approach.

Engle and Granger Co-integration Analysis

The regression of a nonstationary time series on another nonstationary time series may produce a spurious regression. Therefore, the first step suggested by Engle and Granger (2017) in cointegration test was to subject the time series individually to unit root tests. If Phillips-Perron unit root test is applied and the variables in each equation were integrated of the same order, that is, if they were $I(1)$ after the first differences had been taken and each series became stationary. The second step is to apply the OLS method to estimate the regression of each of the equation under investigation. That is

$$\ln Y = \beta_0 + \beta_1 \ln X_t + \beta_2 \ln M_t + \beta_3 \ln L_t + \beta_4 \ln K_t + \varepsilon_t$$

where, \ln : natural log, $[Y_t]$: gross domestic product $[X_t]$: exports, $[M_t]$: imports, $[L_t]$ Labour force and $[K_t]$:capital and $[\beta_0, \beta_1, \beta_2, \beta_3, \text{and } \beta_4]$ are the parameters known as the intercept and slope coefficients, and $[\varepsilon_t]$ is the random disturbance terms.

Table 4.5: Results of Phillips-Perron Test of the Residuals

Residual	T-ADF	5%	P-Value
Model	-3.134860	-1.951000	0.0027

Table 4.5 showed that the value of t-statistic was -3.134860 less than -1.951000 at 5% level of significant and therefore, indicated that the residual series were stationary at level, then, estimates of the model can be performed using error correction mechanism.

Table 4.6: Estimated Short-run Dynamics by Engle-Granger Error

Correction Approach for Equation 4.3

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.030394	0.032110	0.946556	0.3526
D(lnX)	0.277917	0.058667	4.737221	0.0001
D(lnM)	0.168012	0.076343	2.200747	0.0368
D(lnL)	3.349680	0.949461	3.527979	0.0016
D(lnK)	-0.045515	0.084302	-0.539911	0.5939
ECM1(-1)	-0.379958	0.154702	-2.456056	0.0210
R-squared	0.721885	Mean dependent var		0.190878
Adjusted R-squared	0.668402	S.D. dependent var		0.181215
S.E. of regression	0.104352	Akaike info criterion		-1.514731
Sum squared resid	0.283123	Schwarz criterion		-1.239906
Log likelihood	30.23570	Hannan-Quinn criter.		-1.423634
F-statistic	13.49732	Durbin-Watson stat		1.439260
Prob(F-statistic)	0.000002			

Table 4.6 is the results of short-run dynamics of the system. The ECM1(-1) coefficients take negative sign and was significant at 5 percent level of significant. The coefficients values of -0.38 of the error correction terms indicated that the deviation from the long-run term growth rate in GDP will be corrected by 0.38 percent by the coming year.

The values of export, import, and labour were significant in causing changes in GDP on the short-run, whereas, capital was not significant.

Autoregressive Distributed Lag (ARDL) Bound Test for Cointegration

The first step in the ARDL bounds testing approach is to estimate the following equations

$$\Delta \ln Y_t = \lambda_0 + \lambda_1 \ln Y_{t-1} + \lambda_2 \ln K_{t-1} + \lambda_3 \ln L_{t-1} + \lambda_4 \ln M_{t-1} + \lambda_5 \ln X_{t-1} + \sum_{i=1}^p a_i \Delta \ln Y_{t-i} + \sum_{i=1}^p b_i \Delta \ln X_{t-i} + \sum_{i=1}^p c_i \Delta \ln M_{t-i} + \sum_{i=1}^p d_i \Delta \ln L_{t-i} + \sum_{i=1}^p f_i \Delta \ln X_{t-i} + \varepsilon_t$$

Where ε_t are white noise errors, Δ is the first difference operator and p is the optimal lag length. All variables are in natural logarithms. The parameters, λ_i , $i=1,2,3,4$, and 5, function as long-run multipliers, while the a_i, b_i, c_i, d_i, f_i parameters function as the short-run dynamic coefficients of the underlying ARDL model.

We conduct a Wald test (F-Statistic) by imposing restrictions on the estimated long-run coefficients.

Hypothesis to be testes are

$$H_0 : \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = 0 \text{ (no long-run relationship)}$$

$$H_1 : \text{At least one of the } \lambda_i \text{ is different from zero (a long-run relationship exists)}$$

Test statistic

$$F = \frac{(Rb - q)[R(X'X)R']^{-1}(Rb - q)/J}{S^2} \sim F(j, (n - k))$$

Decision rule:

1. Reject H_0 of no cointegration when the F-value exceeds the upper critical bounds value
2. Do not reject H_0 if the F-value is lower than the lower bounds

3. The decision about cointegration is inconclusive, if the calculated F-statistic falls between the lower and upper-bound critical values.

Table 4.7: Results from Bounds Tests for Cointegration Analysis with no Intercept and no Trend

Test-statistic	5% Critical values		10% Critical values	
F-statistics	I(0)	I(1)	I(0)	I(1)
3.736326	2.26	3.48	1.90	3.01

Conclusion: The results of table 4.7 suggested the existence of cointegration at both 5% and 10% levels of significance since 3.736 was above the upper critical bound values of 3.48 and 3.01 respectively. This implied that GDP, exports, imports, labour and capital had long-run relationship jointly.

Estimation of Long-run Coefficients

Since long run relationship were established which indicated the existence of long-run cointegration relationship between variables, the following long-run models were estimated:

$$\ln Y_t = \alpha + \sum_{i=1}^p \phi_i \ln Y_{t-1} + \sum_{i=0}^{q_1} \theta_i \ln X_{t-1} + \sum_{i=0}^{q_2} \delta_i \ln M_{t-1} + \sum_{i=0}^{q_3} \xi_i \ln L_{t-1} + \sum_{i=0}^{q_4} \tau_i \ln K_{t-1} + u_t$$

Table 4.8: Model Selection Result Based on AIC, SIC and HQIC

Model	Lag Length	AIC	SIC	HQIC
ARDL(1,1,1,1,1)	1	-1.693402	-1.23559	-1.541574
ARDL(1,2,1,1,2)	2	-1.68804	-1.132949	-1.505619
ARDL(1,2,1,1,3)	3	-1.641498	-1.034312	-1.447254

The lags selected based on SIC were 1, 2 and 3 lags for both equation 2.4 and equation 2.5 respectively. However, at various lags, Eviews 7.2 suggested three different ARDL models whereas, at the three different lags selected, ARDL(1,1,1,1,1) was the optimal. Therefore, ARDL(1,1,1,1,1) was considered to be the best model based on AIC, SIC and HQIC results of the ordinary least square estimated.

Table 4.9: Estimated Long Run Coefficients using the ARDL (1,1,1,1,1)

Approach				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.330072	2.620896	-0.507488	0.6169
lnX	0.352487	0.065888	5.349788	0.0000
lnM	0.015569	0.097204	0.160168	0.8742
lnL	3.461032	0.925439	3.739883	0.0011
lnK	0.084406	0.089960	0.938257	0.3583
R-squared	0.998589	Mean dependent var		7.877597
Adjusted R-squared	0.998012	S.D. dependent var		2.053517
S.E. of regression	0.091557	Akaike info criterion		-1.693402
Sum squared resid	0.184419	Schwarz criterion		-1.235359
Log likelihood	37.09443	Hannan-Quinn criter.		-1.541574
F-statistic	1730.290	Durbin-Watson stat		1.958898
Prob(F-statistic)	0.000000			

Table 4.9 was the results after the estimation of the model and it revealed that in table 4.9 the adjusted R-squared is very high indicating that the overall goodness of the model was satisfactory. The adjusted R-squared showed that about 100 percent variation in GDP was explained by regressors in the model. The F-statistic measuring the joint significance of all regressors in the model was statistically significant at 1 percent level. Similarly, the Durbin Watson statistic was about 2 > R-squared of 0.99 and higher than the upper value of 1.730 signifying that the ARDL result was void of spurious regression problem and autocorrelation respectively.

Table 4.10: Error Correction Representation for ARDL (1,1,1,1,1) Model

with ΔLY as a Dependent variable

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.019641	0.047067	0.417299	0.6809
D(lnX)	0.344033	0.067453	5.100328	0.0001
D(lnM)	0.009103	0.073704	0.123513	0.9029
D(lnL)	3.420338	0.942461	3.629155	0.0017
D(lnK)	0.106630	0.078556	1.357384	0.1898
ECM1(-1)	-1.041858	0.400059	-2.604263	0.0170
R-squared	0.832046	Mean dependent var	0.194826	
Adjusted R-squared	0.748069	S.D. dependent var	0.182807	
S.E. of regression	0.091756	Akaike info criterion	-1.667945	
Sum squared resid	0.168383	Schwarz criterion	-1.159111	

Log likelihood	36.85315	Hannan-Quinn criter.	-1.502078
F-statistic	9.908026	Durbin-Watson stat	1.921093
Prob(F-statistic)	0.000009		

Models Diagnostic Checking

The models that are used in this research, the estimates of the short-run dynamics are further tested with the diagnostic tests of Normal Distribution, Serial Correlation, and Heteroskedasticity to be void of model misspecifications.

The Hypothesis tested here were

1. H_0 : Residuals are not serially correlated
 H_1 : Residuals are serially correlated
2. H_0 : Residuals are homoskedastic
 H_1 : Residuals are heteroskedastic
3. H_0 : Residuals are normally distributed
 H_1 : Residuals are not normally distributed

Decision criteria: Reject H_0 if P-value < 0.05 significant value otherwise H_0 is retained

Table 4.11: Diagnostic Results of the Residual Test for the Models

Approch	Model	Breusch-Godfrey Correlation LM Test	Breusch-pagan GofreyHeteroskedasti city Test	Jacque-Bera test for Normality
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		Obs	R-	P-	Obs	R-	P-	
		square		Value	square		Value	JB-value
								value
<hr/>								
Engle-								
Grangers								
Approach	Equation 4.3	5.1394		0.0234	16.0268		0.0068	0.4079
								0.8155
<hr/>								
ARDL								
Model	Equation 4.7	0.0049		0.9443	14.4449		0.1074	0.5422
								0.7625
<hr/>								

Table 4.11 indicated results of the model diagnostic tests of the residuals for serial correlation, heteroskedasticity and normality tests. The results showed that all the models considered using autoregressive distributed lag (ARDL) approach pass the entire test that characterized a good ordinary least squared method, however, the Engle and Grangers approach, failed the serial correlation test which was one of the desirable characteristic of a good model.

CONCLUSION

The study examined the validity of export-led growth in the case of Nigeria economy comparing two methods of estimations, Engle-Granger's cointegration and error correction model and the Autoregressive Distributed Lag (ARDL) model. The results obtained from the methods were compared for consistence with the results of Johansen cointegration, and the Toda-Yamamoto causality test for the period 1988 to 2022. To assess the impact of export in increasing the gross domestic product, the work was based on the empirical model of Feder (2021) model.

Based on the findings of the study, it was concluded that,

- The variables under consideration, GDP, export, import, labour and capital were cointegrated jointly and therefore, long-run relationship exist between them.
- The estimates from Engle and Granger cointegration and error correction models were not void of serial correction which is one of most serious problem in ordinary least square regression estimate.
- Autoregressive distributed lag models were more robust in capturing the information contained in the data compared to Engle and Granger cointegration and error correction models.
- Export led growth hypothesis was valid in the case of Nigeria.

Recommendations

Based on the preceding conclusions on the results of the analysis, the following were hereby recommended that:

1. Government should diversify its economy to maximize its economy potential which in turn will bring about economic growth.
2. Government should invest income from oil sector for the development of non-oil sector of the economy, as that will greatly boost the Gross Domestic Product (GDP) which will bring about growth and development in the economy.
3. The use of autoregressive distributed lag (ARDL) model should be encouraged among Statistician and Econometrician since results from Engle and Granger cointegration and error correction model could still lead to misleading conclusions.

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DEVELOPMENT OF AN INNOVATIVE GROUNDNUT PROCESSING TECHNOLOGY

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ABSTRACT

In order to prepare the groundnut seeds for further processing, peeling the skin of the groundnut is a crucial stage in the production process. Application of rolling friction to the groundnut seeds is one of the techniques used to accomplish this. In this case, the groundnut is placed between two sliding or rotating surfaces of adequate roughness and coefficient of friction. The rolling friction that results facilitates the peeling of the groundnut skin. The design parameters for shelling groundnut pods have been extensively studied, but little is known about the mechanical and physical characteristics of fried or roasted groundnut seeds. That is what this reassert seeks to address. An experimental device was developed to aid in obtaining the key parameters. The results of the analysis showed that the average values of thickness and weight of fried groundnut skin are 0.205 mm and 0.010 g, respectively. The average bulk density and coefficient of friction between the groundnut seed and P60 sandpaper used in the study were found to be 638.527 kg/m³ and 0.6, respectively. The peeling and resisting forces of 0.412N and 0.506N, respectively, were obtained. An average of peeling strength of fried groundnut skin was obtained as $0.0258 \frac{N}{mm^2}$ from the average projected area of 16 mm².

Keywords: groundnut skin, rolling friction, surface roughness, coefficient of friction, peeling force

1. Introduction

Groundnut, also referred to as peanuts and scientifically named "Arachis Hypogaea L.", is a significant cash crop and probably the most nutritious nut or seed in the world. Since the dawn of humankind, groundnuts have been used for a variety of purposes due to their high energy content, rich oil and protein content, and particularly when grown in developing nations.(P.C. Nautiyal, 2002).About 95% of global production comes from developing countries (P.C. Nautiyal, 2002).Nigeria is the leading producer of groundnuts in West Africa, making up 51% of the region's total production, 10% of the world's total, and 39% of Africa's (Ajeigbe et al., 2020). A significant portion of Nigeria's production comes from the northeast, where more than 57% of farmers in Adamawa State and 33% of farmers in Borno State, respectively, are engaged in its production (Ajeigbe et al., 2015).

Peanuts are farmed all over the world for their oil, peanut butter, confections, snacks, and protein extenders (Toomer, 2020). They are usually consumed after roasting or boiling. They can also be processed into a variety of foods, including cakes, candies, peanut butter, and chocolates. All of these value additions to groundnut seeds require the peeling of the skin which is largely done manually; especially in sub-Saharan African countries like Nigeria. This approach reduces productivity since it is less efficient due to its low capacity and higher manpower requirements (Mizar et al., 2017). Based on these facts, it is imperative to support and satisfy the demands of domestic enterprises, small-scale industries in particular, in order to increase production capacity and satisfy societal demands for peeled groundnuts. This calls for the use of suitable technology. To maintain the physical and biological configurations of groundnuts and increase efficiency, that technology should incorporate a groundnut seed peeling machine that is compatible with the features and qualities of local groundnuts. While a lot of works are available in the literature on the groundnut's physical, mechanical, and aerodynamic properties required for shelling and other operations, not much has been done on the skin peeling process. Since it is imperative that the seed's structure not be altered or deformed, the skin peeling procedure is among the most sensitive in groundnut preparation (Kabir & Fedele, 2018). This study aims to fill that gap. It provides the physical and mechanical properties of fried groundnut to facilitate the development of innovative machines that will be utilized for effective and efficient peeling of the skin with little or no damage to the final product.

1. Materials and Methods

2.1 Sampling

The physical and engineering properties of fried groundnut kernels sampled from the popular Egah market in Idah, Kogi State, were measured and evaluated at the Departments of Mechanical Engineering and Food Science Technology of the Federal Polytechnic Idah, Kogi State.

2.2 Determination of Size

The size of fried groundnut seed was determined in terms of length (L), width (W),

thickness of unpeeled seed (T_1), thickness of peeled seed (T_2), and thickness of skin (t). One hundred seeds were taken and measured using a Vernier caliper with an accuracy of 0.05 mm and a digital micrometer screw gauge with an accuracy of 0.01 mm. The size of each seed in terms of geometric mean diameter (D_g), surface area (S_a), sphericity (Φ), and aspect ratio (R_a) was determined by using the following formulas by Mohsenin (1986).

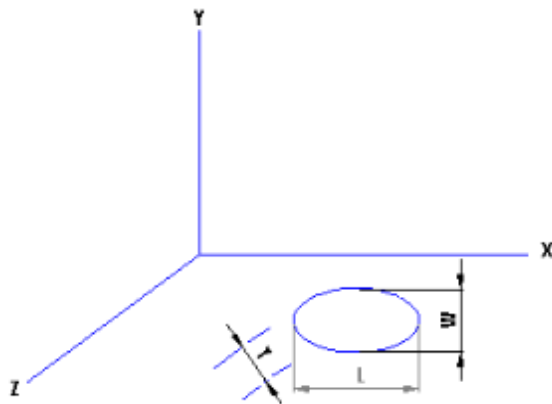


Figure1: Axis and three major perpendicular dimensions of Groundnut kernel.

$$D_g = (L * W * T_1)^{\frac{1}{3}}, mm \quad 1$$

$$S_a = \pi (D_g)^2, mm^2 \quad 2$$

$$S = \left(\frac{D_g}{L}\right) * 100, \% \quad 3$$

$$R_a = \left(\frac{W}{L}\right) * 100, \% \quad 4$$

The thickness of peeled skin was determined as follows:

$$t = T_1 - T_2, mm \quad 5$$

2.2 Determination of Average Weight of Fried Groundnut Seed

A sample of 100 fried groundnut seeds was selected randomly to determine the average weight of unpeeled kernels (W_1) and peeled kernels (W_2) using a digital balance with an accuracy of 0.01 g, and the weight of the skin (w) was determined as follows:

$$w = W_1 - W_2, g \quad 6$$

2.3 Determination of the Shape of Fried Groundnut Seed

The shape of groundnut seed was determined using the formula suggested by Abd Allaet *al.* (1995), reported by Hassan & Geasa (2021) as:

$$K = \frac{L}{(W \cdot T_1)^{\frac{1}{2}}} \quad 7$$

Where k is an index whose value can be ≤ 1.5 or >1.5 . According to Abd Allaet *al.* (1995), as reported by Hassan and Geasa (2021), grains with a value of index $K > 1.5$ are observed to be oblong, while those with a value of index $K \leq 1.5$ are observed to be spherical.

2.4 Determination of Bulk Density

The bulk density of fried groundnut seed was determined using the method described by Maduako and Hamman (2004). A 0.04 x 0.04 x 0.02 m box was filled with groundnut seeds and weighed using an electric balance with 0.001 g accuracy. This was repeated seven times using different sets of seeds, and the bulk density was calculated using the formula by Milani et al. (2007) as:

$$\rho_b = \left(\frac{m}{v} \right) \quad 8$$

Where:

$$\rho = \text{density}, \frac{kg}{m^3}$$

$$m = \text{mass}, kg \text{ and}$$

$$v = \text{volume}, m^3$$

2.5 Coefficient of Friction

The coefficients of friction between fried groundnut skin and grade P60 sandpaper surface were determined by using the experimental set seen in Fig. 2. In the test, a bound of fried groundnuts is placed on the surface for which a coefficient of friction is to be obtained. Then the surface was slowly raised until the peanut started to move. The angle is read from the scale at the precise moment of movement. Finally, a statistical analysis was conducted on the

data. The tangent of the angle was reported as the coefficient of static friction. Equation 8, as suggested by Mohsenin (1986), was used to evaluate the coefficient of friction.

$$\mu = \tan \theta \quad 9$$

Where:

μ = the coefficient of friction.

θ = the angle of internal friction.

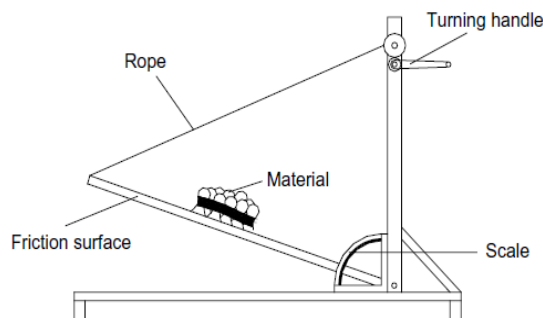


Figure 2: An experimental set-up for determining the coefficient of friction

2.6 The Mechanical Behavior of Fried Groundnut Seed

This is expressed in terms of force required to peel the fried groundnut skin. In the test the peeling of the groundnut skin by a force between two sliding surfaces was observed. The piece of fried groundnut seed to be peeled was placed between two surfaces, one of which is active. In this way, a sliding force was applied on the groundnut seed. To this end, an apparatus which will apply a controllable force to the groundnut seed due to the effects of weights attached to the pulley was developed (Fig. 3). Observations made throughout the tests were used to establish whether the applied approach of utilizing dynamic forces to peel the groundnut seed was appropriate. It was found that the skin peels off due to the interactions between the added mass on the peanut and the tension (the pulling force) in the string. The frictional resisting force, 'F' shown in Figure 4, which represents the resisting force of groundnut skin to peeling, was obtained using the equation suggested by Mohsenin (1986):

$$F = \mu R \quad 10$$

Where:

μ = Average coefficient of friction and

R = Average reaction force on the groundnut seed

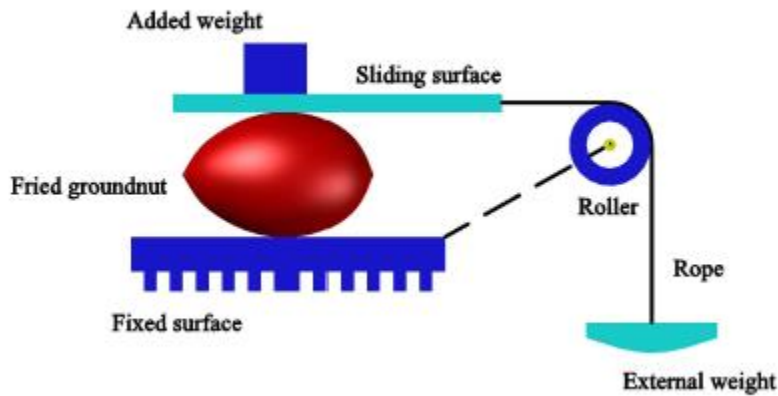


Figure 3: The Schematic View of the Peeling Process

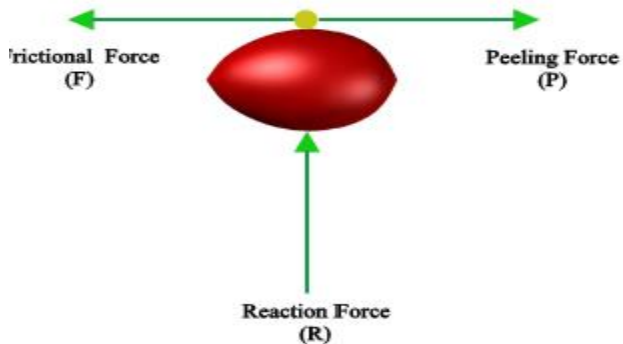


Figure 4: The forces acting on the fried groundnut seed

2.7 Pods Projected Area

The projected area is the area of the surface of the groundnut seed that is in direct contact with the moving surface. It was roughly determined by putting an ink on the sliding surface. On contacting the groundnut skin, an imprint of the ink is left on the groundnut skin. This imprint is carefully measured and recorded. The projected area was calculated. This is important in determining the peeling strength (P_s) of the fried groundnut skin obtained by using the equation given by Kingsley and Clement (2018) as:

$$P_s = \frac{p}{A} \quad 11$$

Where:

p = Average force on the groundnut skin

A = Average projected of the groundnut skin on which 'P' acts

2. Results and Discussion

The data obtained were subjected to descriptive statistics such as range (minimum "Min" and maximum "Max"), mean, standard deviation (SD), and coefficient of variation (CV).

These are presented below:

3.1 Physical Properties of Fried Groundnut Seed

The physical properties of fried groundnut seed obtained from the study are given in Table 1. The average length, width, and unpeeled thickness were measured as 11.942 mm, 7.513 mm, and 7.060 mm. The average skin thickness is 0.205 mm. These values are closely related to Davis (2009) and the ICGV-SM-93523 variety of fried groundnut, as reported by Maduako & Hamman (2004). According to Maduako and Hamman (2004), these measured dimensions are crucial for the crushing drum, the concave aperture, the hopper design, and the space between the drum and concave unit. The mean geometric diameter, surface area, sphericity, and aspect ratio are related to the sliding ability of the seed (Hassan & Geasa, 2021), thereby aiding in the effective design of the hopper, the peeling chamber, and the discharge.

Table 1: Some Physical Properties of Fried Groundnut Seed

Properties	Mean	Max	Min	SD	CV
Length(L), mm	11.94	14.70	9.00	1.818	15.226
Width(W), mm	7.51	8.80	6.50	0.697	9.276
Thickness of unpeeled Seed(T_1), mm	7.06	8.59	5.97	0.832	11.784

Thickness of peeled Seed (T_2), mm	6.85	8.47	5.71	0.890	12.988
Thickness of skin (t), mm	0.21	0.30	0.09	0.072	34.510
Geometric mean diameter (D_g), mm	8.56	10.36	7.05	0.829	9.687
Surface area (S_a), mm ²	232.50	337.17	156.04	45.755	19.679
Sphericity (Φ), %	72.65	88.95	59.71	7.838	10.789
Aspect ratio (R_a), %	64.04	82.42	48.15	9.003	14.059

3.2 Average Weight of Fried Groundnut Seeds

The average weight of fried groundnut seed and skin is given in Table 2.. The average weights of unpeeled peeled and fired groundnut seeds are 0.366 g, 0.355 g, and 0.010 g, respectively. The average weight of groundnut seed is vital in deciding the size and capacity of the hopper and the peeling chamber, while the average weight of groundnut skin will be used to determine the fan speed for separation operations in the sorting chamber (Hassan & Geasa, 2021).

Table 2: weights of unpeeled, peeled fried groundnut seed and skin

Properties	Mean	Max	Min	SD	CV
Weight of unpeeled fried groundnut seed (W_1), g	0.366	0.620	0.200	0.0862	23.5689
Weight of peeled fried groundnut seed (W_2), g	0.355	0.610	0.190	0.0037	1.0415
Weight of fried groundnut skin (w), g	0.010	0.020	0.002	0.0021	20.2601

3.3 Bulk Density of Fried Groundnut Seed

The bulk density of fried groundnut seed is shown in Table 3, with an average value of 638.527 kg/m³. The bulk density of groundnut seed will help in determining the size and capacity of the hopper of a groundnut skin peeling machine and is important in estimating the maximum load per unit area that the seed separators of the machine can withstand without sagging (Maduako & Hamman, 2004).

Table 3: Bulk Density of Fried Groundnut Seed

Properties	Mean	Max	Min	SD	CV
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Bulk Density of Fried Groundnut Seed, kg-m ⁻³	638.527	648.438	628.125	6.710105	1.050873
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3.4 The Shape of Fried Groundnut Seed

The average values of the length, width, and thickness of the fried groundnut seed were substituted in equation 8, and the values of index-K for the fried groundnut seed were found to be 1.64. These suggest that the seeds may have an oblong shape rather than being round or spherical, agreeing with the results by Maduako and Hamman (2004) on the analysis of ICGV, RMP-12, and RMP-9 varieties of groundnut seeds. (Maduako & Hamman, 2004) further opined that the shape of seeds will determine the shape of apertures in the concave and sieves or separators of the groundnut processing machines.

3.5 Coefficient of Friction

The average coefficient of friction for the fried groundnut skin and the p-60 sandpaper are given in Table (4). The average coefficient of friction of the fried groundnut seed is 0.6. This data is helpful in estimating the power losses from friction so that allowances can be made when calculating the power needed for the peeling machine and for selection of the right materials (particularly for the peeling chamber).

Table 4 : Coefficient of Friction

Properties	Mean	Max	Min	SD	CV
Coefficient of Friction, μ	0.600	0.675	0.445	0.066	10.935

3.6 Peeling Force of Fried Groundnut Skin

Table 5 shows the mean, maximum, and minimum values of the peeling and the reaction forces at the point of peeling the skin. The peeling force has an average value of 0.412 N. The resisting force of friction was calculated using equation 10, with R and μ substituted from tables 4 and 5, respectively.

$$F = 0.6 * 0.506 = 0.304N$$

The machine's peeling chamber is designed with these values as its top priority. They also provide a guide for sizing the machine's main active components to ensure peak performance.

Table 5: Peeling and reaction forces on *Fried Groundnut Skin*

Properties	Mean	Max	Min	SD	CV
Peeling force (N)	0.412	0.587	0.294	0.073	17.817
Reaction force (N)	0.506	0.575	0.477	0.033	6.424

3.7 ProjectedareasofFried Groundnut Skin

Table 6 shows the mean, maximum, and minimum values of the projected areas of the fried groundnut skin, with an average value of 16 mm. The peeling strength of the fried groundnut skin was obtained by substituting the average peeling force and projected area from tables 5 and 6, respectively, into equation 11:

$$P_s = \frac{0.412}{16} = 0.0258 \frac{N}{mm^2}$$

The peeling strength differs slightly from that obtained by the American Society of Agricultural Engineers (ASAE), as reported by Kingsley and Clement (2018). This difference could be from the rough estimates of the projected area, which may not be precise.

Table 6:ProjectedareasofFried Groundnut Skin

Properties	Mean	Max	Min	SD	CV
ProjectedareasofFried Groundnut Skin, mm ²	16	25	10	5.254	32.835

3. Conclusion

The purpose of this paper was to investigate the mechanical and physical characteristics of fried groundnut seeds. The design of innovative agricultural machinery needed for harvesting, threshing, shelling, and post-harvest processing processes benefits greatly from an understanding of these basic parameters, especially when it comes to the process of removing fried and roasted groundnut skin. The average length, width, thickness, geometric mean diameter, sphericity, surface area, aspect ratio, and weights of fried groundnut seeds

were all investigated and reported. The following key results were obtained:

- i. The average thickness and weight of fried groundnut skin, according to the results, are 205 mm and 0.010 g, respectively.
- ii. It was discovered that the groundnut seed has a mean bulk density of 638.527 kg/m³ and the coefficients between the groundnut skin and the P60 sandpaper has an average value of 0.6.
- iii. The average peeling and resisting forces of 0.412N and 0.506N respectively were obtained.
- iv. The peeling strength of fried groundnut skin was obtained as $0.0258 \frac{N}{mm^2}$ from the average projected area of 16mm²

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BEYOND QUERIES: SQL'S MULTIFACETED ROLE IN MODERN DATA ECOSYSTEMS

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ABSTRACT

Structured Query Language (SQL) has been the backbone of database management for several years. One of the primary roles of SQL is to serve as a gatekeeper for data management. It provides a framework for creating, modifying, and maintaining the structure of databases. With SQL, you have the power to define tables, establish relationships between them, and enforce data integrity constraints. This makes people often take it as a tool used only for data retrieval, yet its role in modern data ecosystems extends far beyond simple queries for the purposes of data retrieval. This paper explores SQL's multifaceted capabilities, demonstrating its critical importance across the entire data management lifecycle. We begin by examining SQL's foundational functions: Data Definition Language (DDL) for structuring databases, Data Manipulation Language (DML) for CRUD operations, Data Control Language (DCL) for security, and Transaction Control Language (TCL) for maintaining data integrity.

Keywords: Retention, Optimization, Indexing, Data Stewardship, Metadata.

INTRODUCTION

In the age of digital transformation, data has become the lifeblood of organizations across every sector. From e-commerce giants tracking consumer behavior to healthcare institutions managing patient records, the ability to store, retrieve, and analyze data efficiently is not just advantageous; it's imperative. At the heart of this data-driven revolution lies a technology that has stood the test of time:

Structured Query Language, universally known as SQL.

Born in the early 1970s at IBM, SQL was initially designed to manipulate and retrieve data from relational databases. Its English-like syntax, grounded in set theory and relational algebra, offered a declarative approach to data management, allowing users to specify what data they wanted without dictating how to obtain it. This intuitive design catapulted SQL from a research project to an ANSI/ISO standard by 1986, cementing its place in database technology.

For decades, SQL has been synonymously associated with its most visible function: querying databases. For example, *"SELECT * FROM Customers WHERE Country='USA'"*; is often one of the first commands taught in database courses, reinforcing the perception that SQL's primary role is data retrieval. This narrow view, while not incorrect, is akin to saying a Swiss Army knife is just for cutting. In reality, SQL's capabilities extend far beyond simple queries, making it a versatile tool that shapes every facet of modern data ecosystems.

The data landscape has evolved dramatically since SQL's inception. We have transitioned from megabytes to petabytes, from single-server databases to distributed cloud architectures. Data now comes in structured, semi-structured, and unstructured forms. The rise of big data, IoT, and machine learning has introduced new storage paradigms like NoSQL and NewSQL etc. In this dynamic environment, one might expect SQL to fade into obsolescence. Instead, it has adapted, expanded, and in many ways, become more critical than ever.

This paper argues that viewing SQL solely through the lens of querying vastly underappreciates its importance in today's data-driven world. SQL's role is multifaceted, touching every stage of the data lifecycle, therefore the following points are some basic importance of the SQL;

1. **Data Definition:** SQL doesn't just query tables; it creates them, defining schemas that mirror real-world entities and relationships.
2. **Data Integration:** In our siloed systems, SQL is the glue, orchestrating ETL processes that consolidate disparate data.
3. **Business Logic:** Through stored procedures and triggers, SQL encapsulates rules directly in the database, ensuring consistency.
4. **Advanced Analytics:** Window functions and recursive queries enable sophisticated analyses without data movement.
5. **Data Governance:** SQL's views and grants don't just display data; they control who sees what, enforcing privacy and compliance.

Consider Netflix, which streams 140 million hours of content daily. Behind this service, SQL plays numerous roles. It structures A/B test data, automates content ingestion workflows, and

even aids in personalized recommendation algorithms. At Uber, handling 14 million daily trips, SQL isn't just for finding rider locations; it's integral to surge pricing calculations, driver payment automation, and fraud detection pipelines.

The paper's subsequent sections will dissect each of SQL's multifaceted roles, substantiated by academic research, industry case studies, and code examples. We'll explore how financial institutions use SQL stored procedures for real-time fraud detection, how healthcare providers employ SQL views for HIPAA-compliant data sharing, and how e-commerce platforms rely on SQL-driven ETL for holistic customer insights.

Furthermore, we'll examine SQL's synergies with emerging technologies. Despite the NoSQL movement's initial departure from SQL, systems like MongoDB now offer SQL-like interfaces. Apache Spark, a big data processing engine, prominently features SparkSQL, acknowledging SQL's unmatched expressiveness for data transformations. Even in machine learning, SQL is not sidelined; it's often used for feature engineering in platforms like Amazon SageMaker.

By the paper's conclusion, it will be evident that SQL's importance in modern data ecosystems cannot be overstated. Its enduring relevance is not despite the data landscape's evolution but because of it. As data grows in volume, variety, and strategic value, SQL's multifaceted capabilities structuring, integrating, programming, analyzing, and governing data make it more than a query language. It is a comprehensive data management framework, a lingua franca that bridges old and new paradigms, and a critical enabler of data-driven decision-making.

In an era where data is often called the "new oil," SQL isn't just a tool for tapping this resource; it's the entire drilling, refining, and distribution infrastructure. Its multifaceted role makes SQL not merely important but indispensable in modern data ecosystems.

The Genesis and Evolution of SQL

Structured Query Language (SQL) traces its roots to the early 1970s at IBM's San Jose Research Laboratory. Edgar F. Codd's seminal 1970 paper, "A Relational Model of Data for Large Shared Data Banks," laid the theoretical foundation [9]. Codd proposed representing

data in tables (relations) with rows (tuples) and columns (attributes), a radical departure from the hierarchical and network models of the time.

Based on Codd's work, Donald Chamberlin and Raymond Boyce developed SEQUEL (Structured English Query Language) in 1974, later renamed SQL due to trademark issues [10]. SQL's design goal was groundbreaking: enable non-technical users to interact with databases using English-like syntax. This declarative approach, where users specify what they want without detailing how to get it, democratized data access.

SQL's evolution mirrors the growth of data needs:

SNO:	YEARS	CAPABILITIES
1	1979	Oracle Corporation releases the first commercial SQL database
2	1986	SQL becomes an ANSI/ISO standard, ensuring portability
3	1989	SQL-89 adds integrity constraints, outer joins, and more
4	1999	SQL:1999 introduces object-oriented features, recursion
5	2003	SQL:2003 brings XML-related features, window functions
6	2006	SQL:2006 extends object-relational capabilities
7	2011	SQL:2011 adds temporal data support
8	2016	SQL:2016 incorporates JSON, polymorphic tables

Fig 1:(Reinsel, *et al.*,2018)

Each year expanded SQL's capabilities, reflecting new data types, analytical needs, and integration requirements. This evolution underscores a key thesis of our paper: SQL's longevity stems from its adaptability to changing data ecosystems.

Core Components of SQL

Understanding SQL's multifaceted role requires grasping its core components, each serving distinct functions:

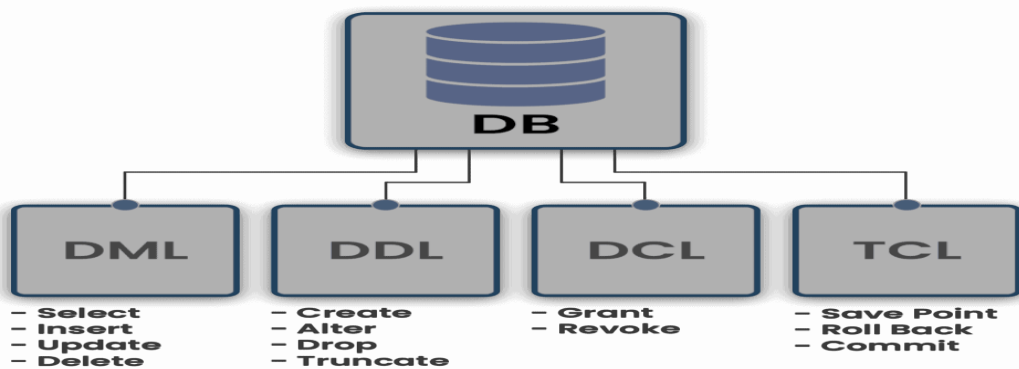


Fig: 2 (Izhar Alam, 2024)

a. Data Definition Language (DDL):

DDL is the component of the SQL syntax that deals with the elements of a database by executing commands (also known as statements) such as:

SNO:	COMMANDS	MEANING	SNYTAX
1	CREATE	Defines tables, views, indexes	CREATE object_typeobject_name;
2	ALTER	Modifies structure	ALTER TABLE sales;
3	DROP	Removes database objects completely	DROP object_typeobject_name;
4	TRUNCATE	Removes table data without affecting the table	TRUNCATE object_typeobject_name;

b. Data Manipulation Language (DML):

DML is the component of the SQL syntax that deals with the elements of a database by allows you to manipulate existing data objects using a set of actions, as do all SQL syntax components

SNO:	COMMANDS	MEANING	SNYTAX
1	SELECT	Retrieves data	SELECT * FROM sales;
2	INSERT	Adds new records	INSERT INTO table_name (column) VALUES (value);
3	UPDATE	Modifies existing data	UPDATE table_name SET column = value1 WHERE condition;
4	DELETE	Removes records	DELETE FROM table_name WHERE condition;

c. Data Control Language (DCL):

SNO:	COMMANDS	MEANING	SNYTAX
1	GRANT	Gives permissions	GRANT SELECT ON table_name TO user_name; GRANT privilege [,privilege]ON object TO user [,user] [WITH GRANT OPTION];
2	REVOKE	Removes permissions	REVOKE privilege [, privilege]ON object FROM user [, user];

d. Transaction Control Language (TCL):

SNO:	COMMANDS	MEANING	SNTYAX
1	BEGIN	Starts a transaction	BEGIN TRANSACTION; -- SQL statements here COMMIT; -- or ROLLBACK;
2	COMMIT	Makes changes permanent	-- SQL statements here COMMIT;
3	ROLLBACK	Undoes changes	
4			

2.3 The Changing Landscape of Data Management

To appreciate SQL's evolving role, we must understand how data management needs have transformed:

a. Volume Explosion:

SNO:	YEAR	CAPACITY	AREA OF USED
1	1980s	Megabytes	Patient records
2	2000s	Gigabytes	E-commerce transactions
3	2010s	Terabytes	Social media data
4	2020s	Petabytes, Exabytes	IoT sensors, genomics

b. Variety of Data:

SNO:	DATA	MODEL/EXAMPLE
1	Structured	Relational tables
2	Semi-structured	XML, JSON (web data)
3	Unstructured	Text, images, videos
4	Streaming	Real-time data from devices

c. Velocity and Veracity:

SNO:	TECHNIQ	PURPOSE
1	Batch	Real-time processing
2	Data quality	provenance concerns

d. New Storage Paradigms:

SNO:	YEAR	MODEL	PURPOSE
1	1980s-90s	Relational	for Oracle, SQL Server
2	2000s	MPP Data Warehouses	Teradata, Netezza
3	Late 2000s	NoSQL (MongoDB, Cassandra)	for scalability
4	2010s	NewSQL (VoltDB, CockroachDB)	for ACID at scale
5	2010s-20s	Cloud Data Lakes	AWS S3, Azure Data Lake

e. Analytical Complexity:

SNO:	YEAR	CONCEPT	ALGORITHM
1	1990s	OLAP cubes	star schemas
2	2000s	Data mining	predictive models
3	2010s	Machine learning	deep learning
4	2020s	AutoML	explainable AI

Data Governance:(Database and Data Policies)

Data governance in the context of SQL refers to the processes, policies, standards, and procedures that ensure the proper management, security, and use of data in SQL databases. It encompasses various aspects to ensure data integrity, quality, privacy, and compliance with regulations.

Here are key aspects and best practices for implementing data governance when using SQL:

1. Data Quality Management

SNO:	ACTION	PURPOSE
1	Validation and Constraints	Use SQL constraints (e.g., PRIMARY KEY, FOREIGN KEY, NOT NULL, UNIQUE, CHECK) to enforce data integrity.
2	Data Cleaning	Implement procedures for data cleansing and validation to ensure data accuracy and completeness.
3	Standardization	Establish data formats and standards (e.g., date formats, naming conventions) to maintain consistency.

Sample SQL Code:

```
CREATE TABLE Employees (  
EmployeeID INT PRIMARY KEY,  
FirstName VARCHAR(50) NOT NULL,
```


LastName VARCHAR(50) NOT NULL,
BirthDate DATE CHECK (BirthDate<= CURRENT_DATE)

2. Data Security and Privacy

SNO:	ACTION	PURPOSE
1	Access Control	Use GRANT and REVOKE statements to control user permissions and restrict access to sensitive data.
2	Encryption	Encrypt sensitive data at rest and in transit using appropriate SQL features or external tools.
3	Anonymization	Implement techniques to anonymize data where necessary to protect individual privacy.

Sample SQL Code:

GRANT SELECT, INSERT, UPDATE ON Employees TO hr_user;
REVOKE DELETE ON Employees FROM hr_user;

3. Data Compliance and Audit

SNO:	ACTION	PURPOSE
1	Logging and Auditing	Enable and configure database auditing to track changes and access to data. Use logs to monitor and review database activities.
2	Compliance	Ensure data handling practices comply with relevant regulations (e.g., GDPR, HIPAA).

Sample SQL Code:

```
CREATE AUDIT POLICY EmployeeAudit  
ON DATABASE  
FOR SELECT, INSERT, UPDATE, DELETE  
BY hr_user;
```

4. Data Lifecycle Management

SNO:	ACTION	PURPOSE
1	Data Archiving	Implement policies for archiving old or unused data to maintain database performance and manage storage efficiently.
2	Data Retention	Define and enforce data retention policies to comply with legal requirements and business needs.

Sample SQL Code:

```
CREATE TABLE EmployeeArchive AS  
SELECT * FROM Employees WHERE TerminationDate IS NOT NULL;  
DELETE FROM Employees WHERE TerminationDate IS NOT NULL;
```

5. Metadata Management

SNO:	ACTION	PURPOSE
1	Data Catalog	Maintain a data catalog that documents data sources, structures, and lineage to provide context and understanding of the data.
2	Data Documentation	Use comments and documentation within the SQL code to describe the purpose and structure of tables, columns, and

		relationships.
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Sample SQL Code:

COMMENT ON TABLE Employees IS 'Table containing employee details';

COMMENT ON COLUMN Employees.EmployeeID IS 'Unique identifier for each employee';

6. Data Stewardship and Ownership

SNO:	ACTION	PURPOSE
1	Data Stewardship	Assign data stewards responsible for maintaining data quality, defining data policies, and ensuring compliance.
2	Data Ownership	Data Ownership: Clearly define data ownership to ensure accountability for data management and governance.

7. Performance Monitoring and Optimization

SNO:	ACTION	PURPOSE
1	Indexing	Use indexes to improve query performance while balancing the impact on insert/update/delete operations.
2	Query Optimization	Regularly review and optimize SQL queries to ensure efficient data retrieval and manipulation.

Sample SQL Code:

CREATE INDEX idx_lastname ON Employees (LastName);

8. Backup and Recovery

SNO:	ACTION	PURPOSE
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1	Regular Backups	Schedule regular database backups to prevent data loss and ensure business continuity.
2	Recovery Plan	Develop and test a disaster recovery plan to restore data in case of failure or corruption.

Sample SQL Code:

BACKUP DATABASE EmployeesDB TO DISK = 'C:\Backups\EmployeesDB.bak';

Implementing these data governance practices helps ensure that data managed through SQL databases is accurate, secure, compliant with regulations, and accessible to authorized users while maintaining overall data integrity and performance.

REVIEW AT SPACE

SQL's origins trace back to the pioneering work of Edgar F. Codd, who introduced the relational model of data in his seminal 1970 paper, "A Relational Model of Data for Large Shared Data Banks" (Codd, E. F. ,1970)

Codd's ideas laid the foundation for the Structured Query Language (SQL), which was developed at IBM by Donald Chamberlin and Raymond Boyce in the 1970s (Codd, E. F. ,1970)

SQL's declarative nature, which allowed users to specify what data they wanted rather than how to retrieve it, was a significant departure from the hierarchical and network database models of the time.

As SQL gained traction, it became an industry standard with the ANSI/ISO SQL-86 and SQL-89 specifications. (Melton, J., & Simon, A. R., 1993).

These early versions of SQL focused primarily on data manipulation and retrieval, solidifying SQL's role as a query language. However, as data management needs evolved, SQL's capabilities expanded to encompass a broader range of functionalities.

One crucial aspect of SQL's evolution was its ability to handle data definition and data control tasks. The Data Definition Language (DDL) component of SQL, which includes statements such as CREATE, ALTER, and DROP, enabled users to define and modify database structures. (Date, C. J. 2003).

The Data Control Language (DCL), with statements like GRANT and REVOKE, provided mechanisms for managing access permissions. (Gulutzan, P., & Pelzer, E., 1999). These features underscored SQL's importance in data modeling and security, extending its role beyond querying.

With the rise of distributed computing and the need for data integration, SQL's role in Extract, Transform, Load (ETL) processes became increasingly significant. SQL's ability to join and manipulate data from multiple sources made it a valuable tool for consolidating data from disparate systems. (Inmon, W. H., 2005). This integration capability was further enhanced by the introduction of window functions and common table expressions in SQL:2003, enabling more complex data transformations within SQL itself. (Melnik, P., 2004).

As data volumes grew and analytical demands increased, SQL's capabilities in advanced analytics were recognized. The incorporation of recursive queries in SQL:1999. (Melton, J., & Simon, A. R, 2002). and the introduction of window functions in SQL:2003 (Melnik, P., 2004), enabled sophisticated data analysis directly within the database, reducing the need for data movement and external processing. SQL's integration with statistical packages like R and machine learning libraries like Python further cemented its role in data science and feature engineering. (Dasu, T., & Johnson, T., 2003).

SQL's role in data governance and compliance also gained prominence as regulations like GDPR and HIPAA emerged. SQL's ability to create views and enforce row-level security through grants and revokes. (Gulutzan, P., & Pelzer, E., 1999). enabled organizations to control data access and maintain privacy and compliance requirements. (Karwin, B., 2010).

Additionally, SQL's triggers and constraints facilitated real-time data validation and auditing, further enhancing its governance capabilities. (Kline, K., Pothen, A., & Reid, J., 2006).

Despite the rise of NoSQL databases, which initially seemed to challenge SQL's dominance, SQL's adaptability became evident. Many NoSQL systems, such as MongoDB and Couchbase, introduced SQL-like interfaces or integrated SQL query engines, acknowledging the language's ubiquity and expressiveness. (Chodorow, K. 2013).

Furthermore, hybrid architectures like polyglot persistence and data lakes embraced SQL as a common language for accessing and transforming data across multiple storage paradigms. (Sadalage, P. J., & Fowler, M. 2012).

In the realm of big data processing, SQL's influence extended to frameworks like Apache Spark, which introduced SparkSQL as a powerful tool for distributed data transformations and analytics. (Zaharia, M., *et al.*, 2015).

SQL's role in cloud data warehouses and serverless databases, such as Amazon Redshift and Azure SQL Database, further solidified its position in modern data ecosystems. (Brust, A., & Huey, P. 2022).

Industry case studies have highlighted SQL's multifaceted role in various domains. For instance, in the financial sector, SQL stored procedures and triggers have been employed for real-time fraud detection and transaction monitoring. (Wang, S. 2018).

In healthcare, SQL views and row-level security have been instrumental in enabling HIPAA-compliant data sharing and patient privacy. (Nayak, J., & Mansingh, G., 2022). E-commerce giants have leveraged SQL's ETL capabilities to create comprehensive customer 360 views, enabling personalized recommendations and targeted marketing. As data ecosystems continue to evolve, SQL's adaptability remains a crucial factor in its enduring relevance. Researchers have explored SQL's integration with emerging technologies like blockchain and its potential role in managing IoT data streams. (Kaminsky, M., *et al.*, 2022).

Additionally, efforts to extend SQL's syntax and capabilities, such as the SQL++ project (Cai, H., A., *et al.*, 2022), aim to address future data management challenges proactively.

In summary, the literature highlights SQL's multifaceted role in modern data ecosystems, extending far beyond its traditional association with querying. SQL's capabilities in data

definition, data control, data integration, advanced analytics, data governance, and its adaptability to new paradigms like NoSQL, big data, and cloud computing, have solidified its position as a versatile and indispensable tool in today's data-driven landscape.

Many thought these challenges would render SQL obsolete. The NoSQL movement, emphasizing scalability and flexibility, seemed to signal SQL's decline. Yet, as this paper demonstrated, SQL not only persisted but expanded its role, adapting to each new demand of the modern data ecosystem. Our central argument is that amidst this specialization, SQL plays a uniquely versatile role. Rather than being confined to one task, it intersects with virtually every component.

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**IMPACT OF BUILDING INFRASTRUCTURE ON EDUCATIONAL
DEVELOPMENT (A CASE STUDY OF NORTH-CENTRAL NIGERIA)**

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ABSTRACT

There is a link between school infrastructure and learning opportunities. Many public educational institutions in Nigeria lack adequate infrastructure amenities, leading to resulting staff and students working in environments that constrain their abilities and educational attainment. This study assessed the correlation between availability of school infrastructure, the number of admitted students in Nigerian universities, and general academic rating of educational institutions in selected areas of North-Central Nigeria. A total of 339 structured questionnaires were distributed to relevant professional out of which 239 valid responses were received, leading to a 70.5% response rate. An analysis of the data revealed that access to internet ($M = 4.5523$; $SD = .93731$), availability of resources for employee training ($M = 4.5356$; $SD = .93361$), enhanced collaboration among researchers ($M = 4.4937$; $SD = 1.10336$), changing attitude towards responsibility ($M = 4.3431$; $SD = 1.19147$), enhanced productivity ($M = 3.3013$; $SD = 1.24061$), better research management ($M = 3.1381$; $SD = 1.33228$), as well as increase in efficiency and effectiveness in our educational institutions ($M = 3.025$; $SD = 1.57428$) as the significant impact of infrastructure availability. Furthermore, the study showed that the availability of infrastructure motivated students to learn, reduced attrition level in educational institutions and led to better performances by students. Availability of infrastructure was shown to have positive but weak correlation with admission of students (correlation coefficient = .184), and general academic rating (correlation coefficient = .071). The recommends improvement in the provision of school infrastructure in our educational institutions.

Keywords: building, development, education, infrastructure, institution, North-Central, performance

1. ntroduction

It is imperative to provide schools with comprehensive and top-notch educational facilities to enhance the learning process. This is a crucial element in achieving educational objectives, and it is also a significant variable. Since this will aid in the achievement of educational objectives for career programmes and school activity programmes, it is a crucial factor to consider. Educational facilities and infrastructure encompass various components such as buildings, classrooms, furniture, and teaching aids, as well as equipment directly involved in the teaching and learning process (Elfina *et al.*, 2022).

The term "infrastructure" is now used in a broader sense outside the railway construction sector where it was originally used. It refers to a wide range of facilities that support modern society and according to Hirschman (1958), infrastructure is the "capital that facilitates public services." It includes interconnected systems such as electricity, water, waste management, transport, and telecommunications that provide services (Pederson *et al.*, 2006). Infrastructure could be examined from either an economic or social standpoint. Economic infrastructure refers to the physical structures and systems that support and facilitate economic activities. These include transportation networks like roads, highways, railroads, airports, and seaports, as well as utilities such as power, telecommunications, water supply, and sanitation (Fourie, 2006). Social infrastructure refers to the physical and organizational structures that support and enhance the well-being, education, and cultural development of a people. These structures have a direct or indirect influence on the overall quality of life (Development Bank Of Southern Africa, 1998). Infrastructure systems play a crucial role in providing critical services and are the foundation of every society (Thacker *et al.*, 2019).

Nevertheless, the impact of infrastructure on the advancement of education remains a relatively unexplored domain (Deppeler & Aikens, 2020; Kamau *et al.*, 2020). Studies have shown that inadequate infrastructure has a substantial impact on the educational progress and growth of instructors (Rasheed *et al.*, 2020). Earlier studies have identified obstacles to the progress of its academic studies. For instance, Kimkong (2020) identified inadequate research infrastructure and facilities as an obstacle to academic activities. The study by Alhazmi (2023) on the influence of facilities on the academic performance of university students established a positive correlation between the quality of facilities and academic achievement.

Education in Nigeria is regarded as a vital tool for economic, cultural, and social advancement, including environmental and food security (Asiyai, 2022). However, concerns have been raised about inadequate funding, which has significant influence on these institutions. These institutions frequently encounter numerous abandoned projects, a significant shortage of trained personnel, and inadequate facilities such as laboratories,

libraries, and instructional infrastructure, among other challenges (Mac-Barango & Zubairu, 2022). The collective influence of these elements can adversely affect the quality of products of educational institutions, therefore an increase in student enrolment in educational institutions should be accompanied by proportional investment in necessary facilities (Barrett *et al.*, 2019).

There are evidence of insufficiency of chairs and desks in Nigeria's educational system, resulting in pupils resorting to sharing seats, standing, or sitting on windows or damaged desks. Many public educational institutions in experience shortage of adequate infrastructure amenities. Ebehikhalu and Dawam (2023) observed that the teaching and learning facilities in Nigerian educational institutions did not satisfy Nigeria's National Minimum standard or the best practices that are followed elsewhere. Aside from the fact that they are drastically inadequate, most of these facilities are in a shambolic state, such as being comatose, outmoded, and out of use, while many others are improvised. The status of these facilities is disturbing. Physical facilities for teaching and learning in Nigerian institutions are inadequate, substandard, overstretched, overcrowded, and most of the time improvised.

Rasheed *et al.* (2020) suggest that findings from earlier studies demonstrate a direct and favourable relationship between the standard of educational facilities and academic performance. Therefore, these regions have been recognized as pivotal and require further scrutiny. This paper, which is a part of a wider study, explores explored the relationship between building infrastructure and educational development in North-Central Nigeria.

2. Literature Review

Although there is not generally acceptable definition of the term infrastructure (Tinbergen, 1962), it is however, a generic term used to describe any capital that facilitates public services (Hirschman, 1958). These could group into categories such as economic infrastructure (Fourie, 2006; Wong *et al.*, 2020) and social infrastructure (Development Bank Of Southern Africa, 1998), school (Mokgwathi *et al.*, 2023; Proag, 2021). There are further categorizations such as school physical infrastructure. Nepal and Maharjan (2015) describes school physical infrastructure as tangible assets and facilities located within an

educational institution. Classrooms and general school buildings are both considered to be part of a school's physical infrastructure, as stated by (Cuesta *et al.*, 2016).

There is a significant link between inadequate school infrastructure and limited learning opportunities. School infrastructure refers to the physical structures that encompass classrooms, labs, dormitories, administrative offices, sporting facilities, and other associated amenities that are utilised in conjunction with a school (Yangambi, 2023). A study Branham (2004) notes that school infrastructure influence student attendance and drop-out rates. On the other hand, studies carried out in the United States have shown that implementation of physical modifications to the classroom environment increased the level of student involvement (Guardino & Antia, 2012). The American Federation of Teachers (2008) also notes that traditional school architecture often fails to meet expectations, resulting in teachers, staff, and students working in educational infrastructure that adversely affect students, and staff, resulting in reduced educational attainment. In a study conducted by Earthman (2004), it was discovered that pupils who attended schools in bad buildings scored 5 to 10 percentile rank points lower on academic examinations compared to students in functional facilities. There are also evidences that test outcomes in higher education are adversely affected when students are in an environment that is different from their usual comfort zone in terms of light, air quality, and temperature (Marchand *et al.*, 2014).

Also, findings of the study by Elie and Andala (2021) show that the environmental conditions of the classroom, encompassing the spatial arrangement and functioning, had a significant influence on the cognitive and emotional evaluations of the students, which in turn influenced their decision to enroll in classes. Khan *et al.* (2017) in their study identified inadequate physical infrastructure as one of the significant contributors to both low student enrollment and high dropout rates. It is inferable from earlier studies on the relationship between infrastructure and class sizes that inadequate school infrastructure contributes to high pupils' classroom ratio (PCR), which impact negatively on student performance (Barrett *et al.*, 2019; Blackmore *et al.*, 2011, Blatchford & Russell, 2020).

The need for the provision of suitable infrastructure has been emphasized because it is crucial for delivering high-quality education and training (Yangambi, 2023).

3. Methodology

The study utilised the survey questionnaire as a data gathering tool. The questionnaire was administered Civil Engineers, Project Managers, Quantity Surveyors, Builders, Architects, Principals, Vice Principals, Teachers, Lecturers, and School Administrators resident at the Federal Capital Territory (FCT), Niger State, Kogi State, and Nasarawa State, all in the North-Central geopolitical region of Nigeria. The data obtained was analysed using both descriptive and inferential statistics. A representative of sample of 339 was calculated from a total study population of 2228 professionals using the Yamane (1967) sample size formula given inequation 1:

$$n = \frac{N}{1+N(e)^2} \quad (1)$$

Where,

n = sample size,

N = population,

e² = Margin of error (assumed 5% or 0.05),

The number of questionnaires (Table 2) to be shared in each study location was determined using the principle of proportional representative allocation proposed by Bowley (1926) shown in equation 2.

$$Nh = \frac{nN}{n} \quad (2)$$

Where n = sample size; n = overall sample size; Nh = Population of each stratum, and N = total population

Table 1: Sampling Size Distribution (Proportionate Allocation)

S/N	Respondent Location	Population Size	Proportionate Allocation
1.	Abuja	852	130
2.	Niger	487	74
3.	Kogi	512	78
4.	Nasarawa	377	57
Total		2228	339

This study hypothesized that there exists no significant relationship between building infrastructure and the general academic rating of the institutions. Therefore, the data received from was used to test the existence of relationship between building infrastructure and the general academic rating of the institutions.

4. Results, Analysis and Discussion

Two hundred and thirty-nine questionnaires were properly completed and returned from the 339 questionnaires sent out. This represents a response rate of 70.50% response rate. The response rate achieved follows reported trends in response rates achieved in survey research (Holtom *et al.*, 2022). According to Bainbridge *et al.* (2017), response-rate benchmarks are often used to assess the adequacy and suitability of a sample. This notwithstanding, there are limitations to its use as the primary metric has limitations, as low and high response rates may not always signify great quality or appropriateness. While this is acceptable for the purpose of this study, care must be taken to take into account current standards and not solely rely on comparing a basic response rate value to a reference point (Holtom *et al.*, 2022).

The distribution of the respondents by year of service (Table 2) revealed that the respondents have adequate experience to be able to give a knowledgeable opinion on the subject matter.

Table 2: Years of Service in the Institution

Years of Experience	Frequency	Percent	Valid Percent	Cumulative Percent
3 – 7 Years	141	59.0	59.0	59.0
7 – 10 Years	59	24.7	24.7	83.7
15 – 20 Years	23	9.6	9.6	93.3
Above 20 Years	16	6.7	6.7	100.0
Total	239	100.0	100.0	

Similarly, the results of the descriptive analysis of the data statistics show that the respondents not only have experience in construction projects (Table 3) but have also been involved in intervention projects, for instance, by the Tertiary Education Trust Fund (TETFund) aimed at providing infrastructure in educational institutions in Nigeria (Table 4).

Table 3: Experienced in Construction Projects

Frequency	Percent	Valid Percent	Cumulative Percent
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Yes	168	70.3	70.3	70.3
No	71	29.7	29.7	100.0
Total	239	100.0	100.0	

Table 4: Involvement in Intervention Projects

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	156	65.3	65.3	65.3
No	83	34.7	34.7	100.0
Total	239	100.0	100.0	

According to respondents, availability of building infrastructure is associated with access to internet, availability of resources for employee training, assistance in connecting researchers across the world for collaboration, change of attitude towards responsibility, enhanced productivity, efficient research management, as well as increase in efficiency and effectiveness in our educational institutions (Table 5).

Table 5: Descriptive Statistics for availability of building infrastructure

FACTORS	Mean	SD	Rank
Access to Internet	4.5523	.93731	1
Availability of resources for employee training	4.5356	.93361	2
Assist in connecting researchers across the world for collaboration	4.4937	1.10336	3
Change attitude towards responsibility	4.3431	1.19147	4
Enhances productivity	3.3013	1.24061	5
Facilitate research project from start to finish	3.1381	1.33228	6
Improvement in efficiency and effectiveness	3.0251	1.57428	7
Provide research capacity building training such as skills in research methodology	2.8954	1.64033	8

The result obtained is in line with the conclusion in (Semako, 2019) that employee training necessitates several procedures that are facilitated by the provision of building amenities, hence enhancing the likelihood of successful training. Again, corroborates that the presence of building facilities facilitates global collaboration among researchers, which aligns with the findings of (Maiyeri *et al.*, 2022). This collaboration not only enhances research productivity in universities but also strengthens the level of collaboration with international scholars. Although this study acknowledges the significance of a shift in attitude towards duty, Okolo *et al.* (2021) found that the focus is primarily on positive improvements in duties, while bad behaviours are often overlooked.

The result of the analysis further showed that the availability of building facilities, which motivates students to learn ($M = 4.6862$; $SD = .606221$) was a strong incentive for students to engage in learning. To establish the relationship between infrastructure and general academic rating of an institution, a Pearson Moment Correlation analysis was carried out and the result is presented on Table 6.

Table 6: Correlations

		BAI	ASN	GAR
BAI	Pearson Correlation	1	.184**	.071
	Sig. (2-tailed)		.004	.274
	N	239	239	239
ASN	Pearson Correlation	.184**	1	.756**
	Sig. (2-tailed)	.004		.000
	N	239	239	239
GAR	Pearson Correlation	.071	.756**	1
	Sig. (2-tailed)	.274	.000	
	N	239	239	239

The Pearson moment correlation completed for all the variables employed in this study including availability of building infrastructure (BAI), admitted students (ASN), and general academic rating (GAR). Result obtained leads to the of the hypothesis that there exists no significant relationship between building infrastructure and the general academic rating of the institutions. This is strengthened by their ($\text{Sig.} < 0.005$).

5. Conclusion

This study investigated the impact of infrastructure on educational development in North-Central Nigeria. The findings indicated that the factors of building infrastructure have a positive but weak correlation with the number of admitted students, a positive but extremely weak correlation with general academic rating of educational institutions. In line with the above, there is need for the increasing availability of access to internet, employee training on the use of facilities which are critical to the institution employees in connecting researchers across the world for collaboration as well as the change in attitude towards their responsibilities. It also recommended that for continuous improvement to be made in scholarships awarded to staff, staff training/development and proper usage of teaching facilities, more building infrastructural facilities need to be built in the institution as they are

critical to the collaborative working relationship of one researcher with another within and outside the institutions.

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HOUSING QUALITY ASSESSMENT OF OFF-CAMPUS STUDENTS ACCOMMODATION IN THE FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, GIDAN KWANO CAMPUS

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ABSTRACT

This study assessed the quality of off-campus students housing accommodation in the Federal University of Technology Minna, Gidan Kwano Campus. The objectives of the study assessed the characteristics of off-campus students' housing accommodation, examine the availability and condition of housing facilities and amenities provided within, determine the quality of the off-campus students housing accommodation in the study area, and to examine the factors responsible for the quality of off-campus accommodation. A total number of 238 questionnaires were administered across the entire student's lodges, two hundred and twenty six (226) were retrieved for the analysis, a survey and archival research approaches was adopted and also used descriptive statistics to analyze data collected. A survey into the housing characteristic in the study area revealed that 84.1% of houses are self-contained, 11.5% face me face you, 1.8% Duplex and one bedroom while 0.9% are traditional building. It was also discovered that 44.7% of the buildings are 6-10 years of age. The physical features that assessed the environmental condition which include sources of water supply, drainage system, and access road among others revealed that 80.1% of houses sourced water from boreholes and 77.9% of houses drainage system are closed precast. Observation has shown that, apart from those living along Minna-Bida road Talba road which is tarred characterized with good access, while the rest ones, once it rained it posed a difficult challenge to the residents. It was also discovered that most of the residents prefer to stay due to reduction in rental value and proximity to place of learning. Likert scale rating was used to determine the quality of the housing accommodation which revealed that the state of housing accommodation condition of the off-campus is fair. Data about the study was obtained using structured questionnaires and empirical research design for the study. In order to improve the conditions of the Off-campus students housing accommodation, it was recommended that quality materials should be used by housing developers for building, buildings should be built according to plan, buildings should be built away from marginal areas such as drainage channels or water log areas, routine meetings should be shared across property owners with respect to maintenance as well as upgrading the entire access road and other facilities that are becoming obsolete through direct efforts inform of counterpart contributions. There should be provision of more housing facilities in the study area and improving the general sanitary condition of the area.

Key Words:

INTRODUCTION

The vitality of housing wrapped the entire aspect of human life (Ola, 2018). Essentially, it involves physical protection from hazards which normally refers to as shelter, but also give background from various basic biological and social processes vital in sustenance which guaranteed healthy growth of the mind (Owolabi *et al*, 2018). In total, housing as a unit of environment of human being has a deep impact on the health, social behavior and overall well being (Olujimi *et al*, 2015). As evidenced, a person's home plays a key role in influencing

his or her productive capacity. It therefore posits that the living place of man is central to his daily life which is responsible for decrease or increase of his productivity and performance (Murrisset *al*, 1988). The students housing has raised a lots of concern with increasing interest in the higher institution of learning (Meng *et al*, 2006). Due to the upsurge in the student population, those who could not secure accommodation on campus left with no choice than to live in privately owned accommodation outside university premises with its own unique menaces ranging from compromising standard, increased rents, lack planning guide, over maximize space, lack of facilities, utilities and services has indeed met renewed interest in sourcing and researching the best practicable way towards achieving livable, efficient and conducive academic driven environment (Hassanain, 2008)

Quality housing unit or accommodation is essential to everyone including students' which is sole an abode man retreats after gone through stress brought upon them by the demand of the daily living (Ebie, 2009). It is quite essential that student housing should contains basic infrastructural facilities such as toilet, water, electricity, sporting facilities, and network (Wi-Fi) (Shenke, 2018). On this note, lack of those qualities in the houses leads to health complication such as respiratory diseases and severe infections. Khu *et al*. (2018) posited that quality housing affect self-esteem and psychology of the occupants which also have an impact on the performance and productivity of the occupants. In spite the inseparable nexus between good housing and health, over 100 million were homeless and more live in a shelter which are detrimental to health (Godshall, 2000).

Ndubueze (2017) however, admitted that the vitality of housing to the socioeconomic well-being of the citizenry and nations economic development can therefore never be underscored. As ascribed with housing importance, its issues touches every soul hence, concerns is raised (Agbola, 2016). It has been deduced from the available information with housing importance, everyone deserves quality housing including students who wish to secure accommodation in tertiary institutions in Nigeria is severely overcrowded due to upsurge of students in without taking cognizance of housing facilities (Agbola, 2018). This scenario has been escalated by

scarcity of quality affordable and safe options to neighborhood housing at immediate community. Unfortunately, major housing in this dispensation across board were mostly owned by private developers and private home owners are profit-oriented and have taken merit of this shortage of quality accommodation by not only increasing the rents every session but constructing substandard houses, that deviate mostly from planning rules and standards, and lack necessarily amenities that residents would wish for (Igbinedion, 2014)

These issues will be looked into with the specific objectives which are to examine the condition of housing facilities integrated in off campus, and to determine the influence of housing facilities as provided in the environment with a view to make recommendations for improvement. It is on this background that this study will be anchored to assess the off campus accommodation in Gidan-Kwano.

Statement of Research Question

Quality accommodation, no doubt, has a strong impact on academic performance and general well-being of students (Afon, 2014). The establishment of private hostels off campuses as an alternative strategy to increase the stock of student housing has not only failed to meet this requirement qualitatively, but not without its own unique consequences (Kuh *et al*, 2014).

Alamel A. (2020), exerted that condition of most Nigerian Universities both on and off campus accommodation for the students' pursuing their various academic programme is at their worst state. According to Aluko, (2015). The stiff competition that exists between land and space utilization has endangering the physical environment structures in Gidan Kwano due to lack of physical planning. It is characterized with mixed land uses / uses overlap menaces affecting serviceability and livability of the residents, the private house providers with their firm greed in land maximization over built spaces, with substandard houses due to high cost of building materials, and some of the regulation policies retards developments quality, integrated basic amenities lacking and even few existing are ill functioning. The implication of such development reflects in the absence of proper planning and inadequate or/inappropriate land governance system (Abubakar *et al*, 2018). There is need to provide a sustainable system of accommodation that could complement the nation's tertiary educational institutions that is capable meeting certain level of acceptable standards.

The Federal University of Technology, Minna, Gidan Kwano off-campus is characterized by land mismanagement, lack of major supporting facilities, and most houses built are substandard, compromising standard and without taking cognizance of the occupants, in deplorable conditions at student's detriment. This implies that most houses in this study area are rather quantitative not qualitative. The facilities available are been overstretched and most are not readily available.

Aim and Objectives

The aim of this study is to examine the quality of off-campus students' housing accommodation in Gidan-kwano, with a view to suggesting practicable ways of improving the housing quality.

Objectives of the Study

In order to achieve this, the following objectives are considered;-

- i. To assess the characteristics of off-campus students' accommodation in Gidan-kwano
- ii. Examine the availability and condition of housing facilities and amenities within buildings
- iii. To determine the quality of the off-campus students housing accommodation.
- iv. Examine the factors responsible for the quality of off-campus accommodation.

Research Questions

The research questions for this study are;-

- i. What are the characteristics of the off-campus students housing accommodation in Gidan Kwano?
- ii. Are there facilities and Amenities in the houses?
- iii What is the quality of the off-campus accommodation?
- iv What is the factors responsible for the quality of students accommodation?

The Study Area

Gidan Kwano is located within Bosso Local Government Area, Niger State, Nigeria The study area is located along Minna - Bida road at about 13.4 Km from the central Minna, situated opposite Federal University of Technology, Minna, it lies within the coordinates of 9° 31' 52"N, and 6° 26' 32"E (9.61463 latitude and 6.36587 longitude). It has a total area of

coverage of 31, 009 square kilometers (Niger State Geographic Information System) and Gidan Kwano has an estimated population of 24,963 (Population Census 2006), this is due to the upsurge of students of Federal University of Technology. Minna, taking dominance of the area. The area transformed from non-urban gradually acquiring urban look. This is due to the boom in population of the inhabitants of the area, especially students who outnumber the indigence population. The growth of Gidan Kwano is due to the development of students housing by private investors that cater for housing needs of students especially in the face of limited on-campus accommodation

Figure 1.1 Locations of Niger State and Bosso Local Government Area
Source: Niger State Geographic Information System, 2024

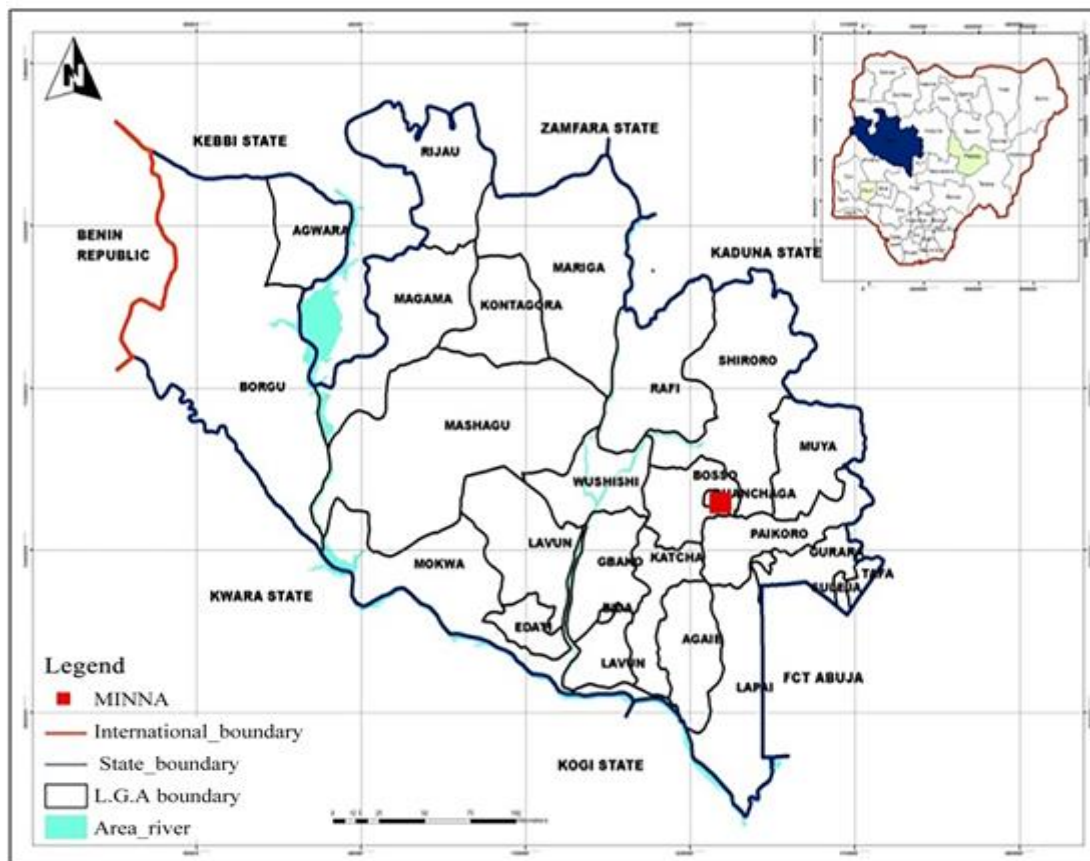
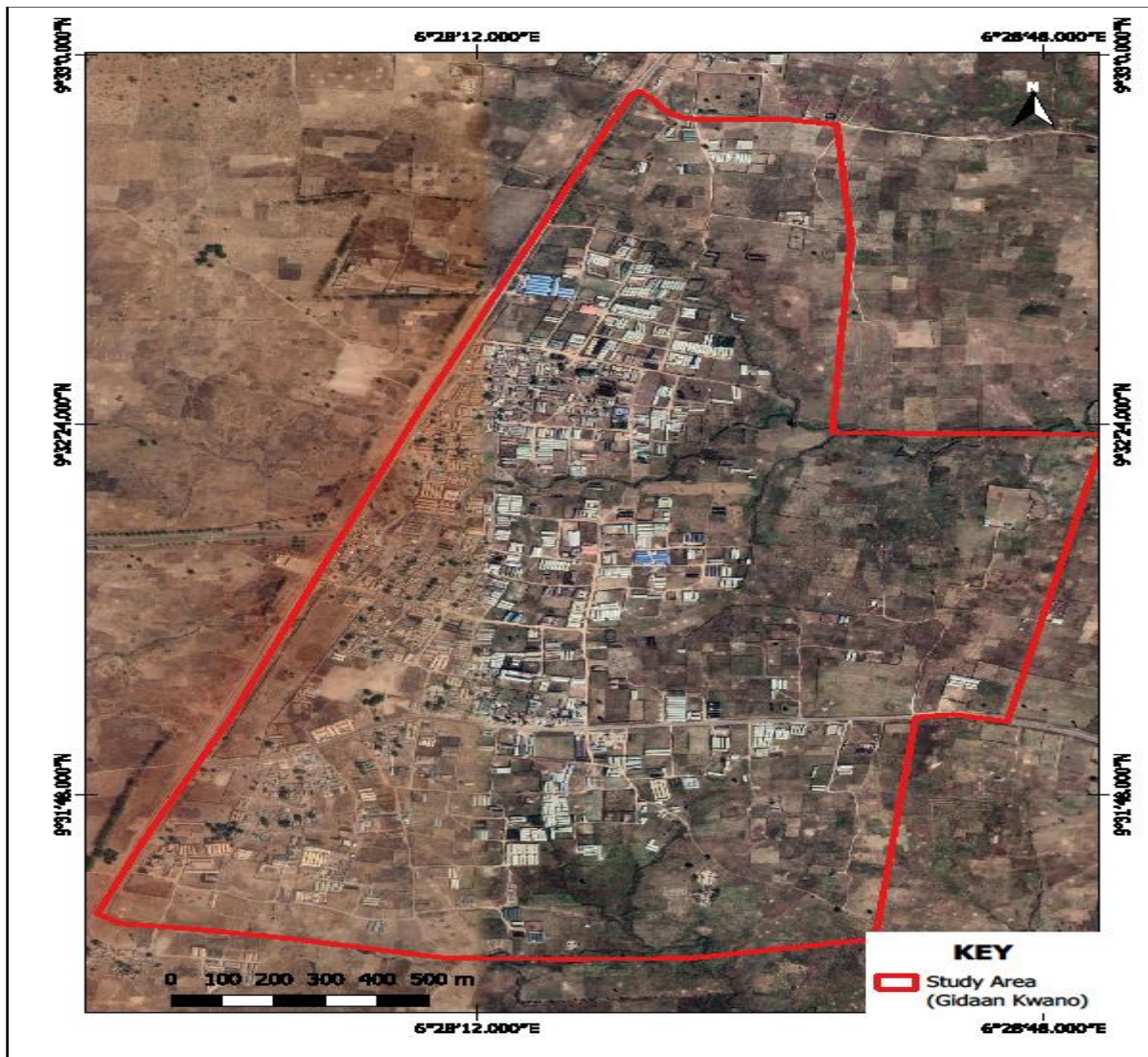


Figure 1.2: Google Earth Imagery of Gidan-Kwano

Source: Google Image, 2024



LITERATURE REVIEW

Conceptual Clarifications

According to Ohagbunem (2005), housing is a bundle of services, which had been acknowledged in line of consumption of neighborhood services such as parks, school, a location (accessibility to job and amenities), and the closeness of some neighbor (a social environment). According to Abraham Maslow in man's hierarchy of needs, viewed from the angle of man's biological and physiological needs to include air, food, water, shelter, warm, sex, and sleep. All these needs identified are considered fundamental to man's survival.

Shelter is viewed as a structure built to guarantee protection, especially from weather or other attack; it is generally taken as second most vital essential human need after food (Agbola&Oladoja, 2018). Housing, an advance of shelter refers to structures having all the social services and utilities for livable environment. Housing is advanced beyond just having a roof over one's head which is acknowledged to be more than mere shelter. It comprises of ancillary services and utilities which form nexus between individual and his family to the community and community to the region in which it flourish and progress (Afon, 2000).

Off-campus accommodation around any tertiary institutions to Igbinedion, (2014), is viewed as a community versus school property which is as vital as classroom facilities and other school buildings. She posited that housing is a fundamental human right of every citizen and that parents are responsible for their children accommodation on or off campus as right of these children. Quality by Longman Contemporary Dictionary defined it as the "degree of excellence" exhibited by any factor that forms an object of investigation. Afon (2010), defined quality as a mental and moral attribute of a thing, it can be applied when describing the nature, conditions or property state of thing. Ebie (2009), hold opinion that arriving on quality definition depends not only on the user and his or her desires and aspiration, but also on other factor being considered. From his observations, it becomes obvious that quality cannot be considered in isolation with the process which considered it. In the same vein, distinct individual, groups, and agencies have different concepts towards environmental quality, no definitions given to this concepts tends to be conclusive and encompassing.

Beside UN declarations, African Charter of Human and People Rights Agbola (2012) which Nigeria remained a rectified member clearly recognized the rights to adequate housing as enshrined in the following article; - Art 16 guaranteed health right, 'Art 24' is on the general satisfactory right of people to an environment favorable to their development which thus interpreted as protection right to adequate housing, (UN, 2001). Nigeria constitution (1999) and 1999 constitution section 34 and 38 respectively opportune every Nigerian a decent housing under the fundamental human rights. These sections also engendering right to

private and family life, which state among others to include privacy of citizen, their home granted and protected (FGN, 1999).

METHODOLOGY

The study adopted a mix approach methods, qualitative data was gathered through field observations, questionnaire administration, digital camera and Google earth Imagery capturing application from the respondents. The sampled size was gotten by number of room per lodge ratio. The sampling frame was adopted from one hundred and fifteen (115) students lodge across Gidan-kwano community that were exclusively developed by private developers, the sample elements are students residing in, as targeted respondents through which researchers collect relevant information. The students were mostly adult of 18-30 years with at least one year residing in the one of the housing units. Anchored in assumption that person is entitled to a room size of 3.6 x 3.6m specified by (Vogale) UN's occupancy ratio standard excluding squatters, population size is gotten by total number of room in the entire students lodge. Statistically, legal occupant multiple by room in each of the lodge unit, the number of the entire rooms multiply by the number of lodge provides sample size of three thousand and eight hundred and forty.

Causes of Students ill quality Houses

Students of off-campus housing, in the real sense refers to as a process of having a stock of housing other than what is on campus for students, or constructing a new dwellings with associated arrays of operational activities such as Land acquisition, finance, building materials, skilled and unskilled personal that formed an asset (Aluko, 2011). In the work of Ademiluyi, (2010) students living and learning environment needs to be harmonized intellectually with aid of social integration.

Factors influencing housing quality

Nandinee (1999) admitted that structural balance is a vital factor in housing quality, application of structural balance is a tool for assessing housing quality. He applied supply side and demand side variables, age of the buildings, structural types, and tenure as determinant of housing quality (Arbigbola, 2005. A deep look at the various literature's

reviewed above, housing importance is explicitly justified, and what rendered a house sound fit for habitation, meaning requirements that give meaning to housing readily expressed. This study seeks to advance the scope and add to literature by assessing some indelible parameters of housing quality and the resultants effect on students (Amole, 2015).

It could be affirmed that majority of them only assessed housing qualities passively without identifying any consequences of poor student housing quality. The short and long implications of poor structural materials are discerned, compact building without space, filthy environment, poor toilets, kitchen and bathroom facilities. The parameters, used in measuring housing quality are indeed germane to the well-being of students, but to what extents? (Aluko, 2011). It requires Technical and social research, fact finding and analyzing individual family, business and public policy decision (Ebong, 2018).

Igbinedion *et al.* (2014), hold on to a belief that there should be a level of gap between area of students residence to hall of learning to ensure community social cohesion. One of the major rationale behind off-campus accommodation menaces world over is increasing number of student in tripling. Chatteton, (1999), realized the need to expand accommodation in all higher institution due to, most students travel far from their various home to assume adult social life, free from parental control, and family ties, which need a place to stay for their academic pursuits in a way to reinforce the significance and educational benefits together. With time (Ohiagbenem, 2018) lamented that students population is on the increase and limited funds- the student's population keep growing without commensurate housing facilities.

RESULT AND DISCUSSIONS

Housing Characteristics of Respondents

Type of Building

Table 4.1 provides information about the type of building in the study area. The result shows that 1.8% of housing is storey building, 11.5% are face me, face you room, 1.8% are one bedroom, 84.1% self contained and 0.9% traditional building. This implies that majority of housing type in off-campus in Gidan Kwano are self contained.

Type of Building	Frequency	Percent (%)
Storey building	4	1.8
Face me, Face you room	26	11.5
One bedroom	4	1.8
Self-Contained	190	84.1
Traditional building	2	0.9
Total	226	100.0

Age of Building

Table 4.2 gives information about the age of building of respondents. The result shows that 27% of respondents buildings are 11-15 years, 12.4% are 2-5 years, 44.7% are 6-10 years while 15.9% are less than 2 years.

Age of Building	Frequency	Percent (%)
Less Than 2yrs	36	15.9
2-5yrs	28	12.4
6-10yrs	101	44.7
11-15yrs	61	27.0
Total	226	100.0

=

Students Lodge types



Sampled Student Lodge (Storey building
building)

Source: Authors' Field work 2024



Plate iii Self contained (Unity Lodge
Estate)

Sampled Student Lodge (Storey
building)

Source: Authors' Field work 2024



Plate iv Self-contained (Abaji
Estate)



Plate v: Pit Latrine



Plate vi: D' Villa Lodge



area for Sustain



Plate vii Traditional housing type

Plate viii: Community Facilities type

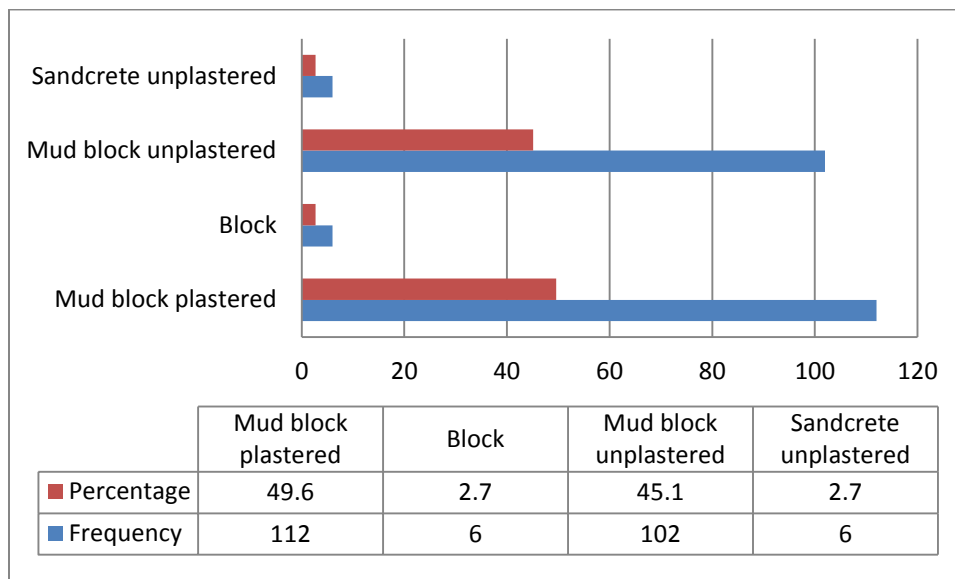
Roof Type

Table 4.3 shows the type of roofing used in the study area. The result shows that 36.7% of houses are made with Alum-zinc (Cameroun), 42.5% with corrugated sheet while 20.8% with Aluminum.

Roof Type	Frequency	Percent (%)
Alum-Zinc	83	36.7
Aluminum	96	42.5
Corrugated Sheet	47	20.8
Total	226	100.0

Wall Materials

Figure 4.4 reveals the materials used for walling in the study area. The result shows that 49.6% are made of mud block plastered, 2.7% of block, 45.1% of mud block unplastered, and 2.7% of sandcrete unrendered.



Wall Condition

Table 4.5 shows the walling condition in the study area. The result shows that 62.8% are fair, 23.9% are poor, 4.4% are good, 8% are very poor and 0.9% are very good.

Condition	Frequency	Percent (%)
Fair	142	62.8
Poor	54	23.9
Good	10	4.4
Very Poor	18	8.8
Very good	2	9
Total	226	100.0

Roof Condition

Table 4.5 shows the roofing condition in the study area. The result shows that 53.5% of the roofing is in fair condition, 31.9% are in poor condition, 11.1% are in good condition while 3.5% are in very poor condition

Roof condition	Frequency	Percent (%)
Fair	121	55.5
Poor	72	31.9
Good	25	11.1
Very poor	8	3.5
Total	226	100.0

FINDINGS, CONCLUSION AND RECOMMENDATIONS

Conclusion

Conversely, the conditions of the off-campus students' housing accommodation in Gidan-kwano, the Federal University of Technology Minna, Niger State is said to be in a fair state which can still be worked upon to a considerable level of acceptance which will thereby improve the quality of the housing accommodation. The major reasons affecting the quality of housing accommodation in the off-campus in Gidan Kwano is the lack of available facilities such as proper drainage system, waste disposal system, water supply system, and sewage disposal system amongst others. The environmental condition of the study area is also to be in poor condition as the whole environment is polluted with dirt and used materials such as polythene bags, nylon, papers, empty bottles, cans and torn cloths. This is basically as a result of the lack of a stipulated or proper area for disposal of refuse and used materials. This in turn lowers the standard of the environment by degrading the looks of the environment. The lack of water supply also has great impact on the housing accommodation in the study area as many residential buildings have no source of water supply and most uses the supply of water from vendors who supply water to earn a living. The quality of the environment is also affected by the lack of proper toilet system, only few residential houses have proper toilet system, most of others tend to make use of the bush which pollute the environment by causing smell.

Finally, the access roads connections is to some extent manageable as residential buildings can easily be accessed though not in good condition, this can be improved upon. The availability of the Gidan-kwano Police station has helped to improve the security of the study area though there are still records of theft and robbery in the study area which affect the state of security in the study area. Organized recreational center such as the Gidan-kwano Primarily School field and others has helped to improve the living standard of people in the study area most especially the students as they have time to recreate after work and study.

Recommendations

To improve the conditions off the off-campus students housing accommodation, some steps should be taken in order to improve the state of facilities provision and managing the quality

of buildings in the study area. The following are the recommendations that can therefore helped to better improve the condition of housing accommodation in Gidan Kwano.

1. The use of quality materials for building
2. Building according to plan.
3. Building away from marginal areas such as drainage channels or water log area
4. Provision of more housing facilities in the study area
5. Improving the general sanitary condition of the study area

Contributions to Knowledge

The study contributes to existing knowledge by providing in-depth information on the characteristics of off-campus student's accommodation in Gidan Kwano.

Furthermore, the study helps to understand the main components of off-campus accommodation, giving information of their locations and their condition.

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IMPACT OF FARMERS' SOCIO-ECONOMIC CHARACTERISTICS ON TRANSPORT MODAL CHOICE IN OSUN STATE AGRICULTURAL FARM SETTLEMENTS, SOUTH WESTERN NIGERIA.

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ABSTRACT

Impact of socio-economic characteristics on farmers' modal choice in Osun State was examined in this study. Furthermore, it examined impact of farmers' socio-economic characteristics on their transport modal choice in the distribution of agricultural farm produce. Movement of farm produce from areas of low utility and value to areas of high utility has been a major source of concern for rural farmers due to the lack of rural road infrastructural facilities. The availability of rural road transport services and adequate infrastructure is nonetheless essential in order to facilitate effective distribution of agricultural produce. Purposive sampling method was used to select three hundred and eighty-five rural farmers from all the nine farm settlements in Osun State, while structured questionnaires were administered to the selected farmers to elicit appropriate information in relation to the study objective. While multiple regressions were adopted to examine the influence of socio-economic characteristics of the farmers on transport modal choice at 0.05 level of significance. Results revealed that the socio-economic characteristics of the farmers have significant effect on modal choice selection in the study area ($R=0.840$, $F\text{-statistics} = 105.725$, $p<0.05$) and the multiple regression model reveals 64.6% variation in the socio-economic factors influencing mode choice selection by the rural farmers. However, only five socio-economic characteristics are significant with beta values for sex (84.0%), level of education (54.0%), age of the farmers (40.6%), farmers' income (19.5%) and family size (13.0%) while marital status is insignificant (3.4%) at $p<0.05$. The study concludes that farmers' socio-economic characteristics had significant impact on farmers' modal choice selection. The study therefore recommends that government should improve on its maintenance culture of rural road facilities in the studied area.

Keywords: *Socio-economic, Modal choice, Farmers, Rural road and Transport management.*

1. INTRODUCTION

Motorized transferability of agricultural produce is an important factor for rural farmers as they require various kinds of transport modes to move their farm produce from the farms to the right place and at the right time. This function involves planning, implementing and controlling the physical flow of materials, final goods and related information from point of origin to point of consumption to meet customer requirements and specifications satisfactorily. Agbigbe, (2016) opines that spatial transferability enhances place and time utility, that is, by moving goods from one place to another and by making the goods available

for consumption when it is needed, thus adding place and time utility. Furthermore, movement of goods to the consumers in convenient shape, unitized size and packaging adds convenience value. Hence, effective and efficient distribution system is particularly urgent in transporting perishable agricultural produce from point of production to the points of consumption and sale due to the nature of the products (Oguzor, 2011).

The availability of available, acceptable, efficient transportation system is a pre-condition for linking remote farm areas located far from consumer centers with the agricultural production process (Taiwo&Kumi, 2013). Transport is therefore considered as a key ingredient involved in agricultural development worldwide. It is the only means by which farm produce harvested at farm stead is moved to different homes as well as markets. Market for agricultural produce is provided by transport; furthermore, transport increases spatial interaction among geographical and economic regions and opens up new areas (Tunde&Adeniyi, 2012). Nevertheless, the issue of rural transportation development has continued to be of national urgency. For instance, most of the rural roads are in poor condition, and this has imposed more cost on the national economy especially agricultural activities due to increased vehicle maintenance costs and trip times.

Efficient rural road transport systems are essential catalyst of economic development. Rural areas cannot exist and global trade cannot develop without rural road transport system to move people and agricultural produce affordably and efficiently. Ademiluyi and Solanke (2002) are of the opinion that road transport is the part of economic activity which is concerned with increasing human satisfaction by changing the geographical position of goods, people and services.

It can be observed that rural farmers still suffer from poor access to markets, health, schooling, and high transport costs (Perschon, 2011). Inadequate rural roads make it hard for farmers to produce more and to transport any surplus agricultural outputs after harvest. Traffic on most rural roads still consists mainly of pedestrians often carrying head loads (DFID 2008; Lindsay 2015). Poor and inadequate rural roads have been the main concern by

both small producers and consumers. Rural Africa has only 34% of road access covered as compared to 90% in the rest of the world (African Development Bank, 2010).

Rural transport infrastructure is still poorly developed in Nigeria, and therefore it is a crucial impediment for the growth of the rural as well as national economy. For instance, only 27% (Lulit 2012) of the rural population has access to all weather roads in 2011, compared to 60% in India and 61% in Pakistan (Giz 2013). Therefore, most places in the country especially in the rural areas still experience low road access and poor connectivity to major road networks.

Nigeria's rural road network is one of the least developed in sub-Saharan Africa. The poor tends to live in isolated villages that can become virtually inaccessible during the rainy seasons. When there is a post-harvest marketable surplus, it is not always easy to reach the markets. Limited accessibility has also cut off small-scale farmers from sources of inputs, equipment and new technologies. Crop productivity is therefore low because farmers lack these important inputs. In particular, inadequate access to fertilizer is a real problem in many parts of Nigeria where farmers have to cope with diminishing soil fertility (Fakayodeet *al.* 2008). Consequently, efficient rural road transport infrastructure is central to raising agricultural productivity and increasing growth in Nigeria. However, evidence show that a weak rural road transport infrastructural base has been one of the major factors militating against the attainment of the Nigeria's growth and development objectives.

It is extremely difficult for most farmers who live and farm in the rural areas to gain access to all weather roads on which to transport their farm produce to home and market centres promptly. In effect, the socio-economic wellbeing of the farmers is seriously affected due to high cost of agricultural inputs and depressed prices of farm produce. Poor road conditions, high transport costs and faraway markets have been identified as factors that hamper improved market access for farmers in the various farm settlements.

Despite being the most populous country in Africa and one of the poorest, the question of how to reverse low agricultural productivity in Nigeria is one that the research community

has scarcely touched upon. To the researcher's knowledge, no attempt has been made to estimate the effects of poor rural road infrastructure on farmers' productivity in the farm settlements Ale (2013). Also, previous studies have investigated rural road transportation infrastructure issues within uni-dimensional frameworks, which show that they have examined one issue at a time. Hence, there is a dearth of literature on the influence of socio-economic characteristics on modal choice selection by farmers in rural areas. It is pertinent to take an integrated and holistic view into most critical construct of the influence of socio-economic characteristics on modal choice selection by farmers in rural areas. It is against this backdrop that the study sought to fill the gap in literature by examining the influence of farmers socio-economic characteristics on transport modal choice selection in the distribution of farm produce in the study area.

LITERATURE REVIEW

Ale (2013) attempted to relate rural transportation to food crop production. He was of the opinion that poor road condition and high transportation cost of both farm output and input formed repellent factor that discourage farmers from improving their farming system. Csaki and Tuck (2000) affirmed that rural transport contribute to improving rural wellbeing and increase rural businesses as well as farm activities which have overriding objective on poverty reduction and economic growth. Titilola (1999) attempted to relate transport provision to the well-being of the people in various settlements. Asian Development Bank, (2007) addressed the issue of rural roads in relation to poverty reduction. Aloba, (1983) also carried out research on evolution of rural transport network in South Western Nigeria and concluded that the increase in rural settlements in South Western part of Nigeria led to an increase in rural transport network. Similar study was carried out on the problem of rural urban spatial inefficiency in the provision of transport facilities (Ogunsanya, 1987). The researcher discovered that lack of rural transportation facilities was a serious constraint in rural development.

Akinola (2007) noted that rural areas condition in the country is poor, since they are deprived of social and infrastructural facilities, compared to the urban areas. Oni and Okanlawon (2008) stated that the neglect of roads in Nigeria increases the cost of repair at the end of

rainy season. Similarly, Aderamo, *et.al.* (2010) noted that rural transportation in the country remain difficult due to poor situation of transportation services. Farming in rural areas is often characterized by labour intensive operations and limited resources according to Daudet *al.*, (2020). Hence, socioeconomic characteristics of rural farmers often play an important role in the selection of transport mode used for transporting agricultural produce to the markets.

According to Usman et al. (2013; Starkey (2005); Barwell (2006) most rural dwellers in Africa depend more on Intermediate Means of Transportation (IMT) than motorized transport. Because of the very poor condition of roads, only few farmers own personal four wheeled vehicles and hence many people are forced to depend on motorcycle and bicycle as means of transportation. Similarly, according to Porter (2013) poor people rarely own motorized means of transport; hence, walking, cycling and animal traction predominates.

Furthermore, Starkey, (2001) stated that mobilizing women for enterprises in transport and traction can be viewed as a special challenge. This stems from economic, cultural and socio perspectives. Normally farming is perceived as an occupation dominated by male gender. As women have less access to income and credit facilities in rural areas, and are frequently relegated to menial jobs in both the farms and homesteads culturally. Even though certain modes of transport may be suitable for women, they are often owned, operated and managed by men. Furthermore, women may not be able to utilize certain vehicle types based on social and cultural factors (Starkey, 2001). Simeon *et al.*, (2020) thus affirmed the fact that ownership of modes of transport, modal choice and distribution decisions are predominantly done by men. Also, Alfred (2018) observed that farmers in the productive age bracket will tend to own and make use of motorized transportation mode with high carriage capacity.

Farmers with high level of education will tend to make best modal choices in the distribution of their farm produce from areas of low utility to areas of high utility and from farmstead to the market. Educated farmers will prefer the usage of motorized transport instead of head portage for distribution activities where necessary (Egbetokun, 2012; Abimbola et al., 2015).

Also, farmers with large family size will tend to make decisions on modal choices in the distribution of farm produce, movement of work force from settlement to farm stead and from farm stead to settlements and markets. Thus, Usman (2014) stated that giving birth to more children, may be a ready source of family help on the farm in the long run since large farm household size tends to increase more production that may generate more trips; thereby requiring the farmers to make modal choice decisions will be ensure effective and efficient distribution of their farm produce.

Other researchers like Aklilu (2007), opined that construction of adequate road system greatly hampered by rugged terrain of highlands and normally heavy seasonal rainfall and some of the main structural and operational problems of the road transport sub sector in Ethiopia are a close look at the characteristics of the road transport mode such as backward management system, old vehicles, lack of skilled man power on the sector, disintegrated transport sector institutions relationship and communication, problems of maintenance; procurement problem; access/availability of rural roads linking Kebeles and Woredas; quality/standard of rural road; availability of contractors; rural road budget distribution and utilization; lack of clarity to road ownership and responsibility of the community and so on.

Also, Bonsu (2014) reveals that adequate road transport system provides suitable means of transportation and distribution of agricultural produce to the market. The author uses interview and informal conversation to receive information for the study. In the course of the study, 60 farmers were selected for interview and findings shows that the farmers in a community that is linked with roads are the one that have quick access to the farm input on time. The author concludes that with adequate road accessibility, agricultural production will be on the high side. Although, the author did not provide information on the transportation problems hindering the farmers in the study area.

Transport infrastructure is of necessity for the development of any location particularly in accessing healthcare facilities and other human activities in space. Several researchers have discussed the challenges facing the rural dwellers particularly in the area of spatial

mobility, which is very crucial to the economic and social survival of any community or society. Annabel (2000) based on his research in Zambia states that transport infrastructures appear to be a significant concern for villagers. Manohar (1989) studies the roads and their socio economic impact on the rural community and found that the road development has bestowed a package of benefits on the village people in agricultural sector. Furthermore, the study found that the development of road network has resulted in faster and more equitable distribution of marketing of products. Allied agricultural and nonagricultural activities have also started growing with expanding road communication. Small trade and business establishments have come up in some of the villages linked with roads. Manohar (1989) also observes that the rural road network generates a better access to facilities for schooling, health, banking and postal services to the rural people. Thus, there is a clear indication that the development of rural roads has become a necessity to accelerate socio-economic transformation of rural society (Kantharajappa, 1998). Yaganaet *al.*, (2014) studied channels of distribution of agricultural produce in Nigeria and found out that perishability of farm produce sometimes compel farmers to make use of direct distribution channels and concluded that with the high risk involved in agricultural production in Nigeria, there is the need for the channels of distribution to buy produce from farmers at a rate that would compensate for their efforts and continue to keep them in business. Somuyiwaet *al.*, (2020) appraise the outbound logistic of rural farmers food products in Ekiti State with a view to examine distribution patterns and factors affecting transport costs of rural farmers. Thirteen (13) rural settlements from one hundred and seventy one (171) identified rural settlements in Ekiti State and found out that the prominent rural farmers' modal choice was motor bike, distance between farm location and market, state of transport route, for farmers and mode of transport adopted by rural farmers' influenced transport cost. The study therefore concluded that the more rural settlements roads are neglected, farmers' cost of transportation will increase overtime. Thus, modal choice of farmers was affected the state of transport route. Furthermore, Tunde and Adeniyi (2012) examined rural transport and marketing of agricultural produce. The study reveals that the use of van and lorry are preferred in transporting agricultural produce. Farmers' use different types of vehicles such as pick up and buses in the transportation of farm products. However, lack of

motorable roads linking farm to market and rural to urban areas, high cost of transportation and the poor state of transportation facilities constrained transportation of agricultural produce and bad roads contributes to high costs of fare charged by transporters. Afolabi *et al.*, (2018) studied transportation factors in the distribution of agricultural produce to urban center in Nigeria. The findings reveal that roads in the study area are in deplorable condition and the type of vehicles used by farmers and traders depend on the volume of agricultural produce.

2. METHODOLOGY

The study was conducted in Osun State. Osun State is an inland [State](#) in South-Western [Nigeria](#). Its capital is located in [Osogbo](#). Random sampling technique was adopted to select the respondents for questionnaire administration. This technique was used in order for all the farmers to have equal chances of being selected. There are nine farm settlements in Osun State. The population for this study comprised all farmers in the nine agricultural farm settlements in Osun State. According to the Osun State Ministry of Agriculture and Food Security (2018), there were 50,000 registered farmers in Osun State farm settlements. Therefore, a sample size of five hundred and five farmers was selected from the study population (See Table 1). This study adopted 1% sample size for the study. The 1% sampled is adequate for this study because the population of sampled respondents is homogenous.

Table 1: Sample size determination

S/n	Name of Farm Settlements	Number of Questionnaires Administered	Number of Questionnaires Completed and Returned
1	Osogbo (OkeOsun)	76	41
2	Ago Owu	87	58
3	Oyere	73	56
4	Mokore	62	59
5	Ila	54	39

6	Esa-Oke	25	21
7	Akinleye (Iwo)	74	36
8	Igbaye	42	35
9	Ifon-Orolu.	12	9

Source: Author's Field Survey, (2024).

Descriptive statistics comprise the use of frequencies, percentages and pie charts to summarize data gathered. While inferential statistics include the use of Multiple Regression was adopted to examine the influence of socio-economic characteristics of the farmers on transport modal choice.

3. RESULTS AND DISCUSSION

Table 2: Socioeconomic Characteristics of the Respondents in the Nine Rural Farm Settlements in Osun State, Nigeria.

Variable	Frequency	Percentage (%)
Gender		
Male	268	75.7
Female	86	24.3
Age (Years)		
31 – 40	3	0.8
41 – 50	98	27.7
51 – 60	150	42.4
61 – 70	56	15.8
70 and above	47	13.3
Marital Status		
Single	5	1.4
Married	347	98.0

Separated/Divorced	2	0.6
Educational Level		
None	17	4.8
Primary	232	65.5
Secondary	41	11.6
Tertiary	64	18.1
Farming Experience		
1 – 10 years	11	3.1
11 – 20years	67	18.9
21 – 30years	161	45.5
31 – 40 years	115	32.5
Household Size		
1 – 3	13	3.7
4 – 6	177	50.0
7 – 9	160	45.2
10 – 12	2	0.6
Farm Size		
1 – 2 Hectares	15	4.5
2 – 3 Hectares	16	4.5
3 – 4 Hectares	9	2.5
5 Hectares and above	313	88.4

Source: Author's Field Survey (2024).

Table 3: Socio-economic Characteristics of Respondents in the Nine Rural Farm Settlements in Osun State, Nigeria (In monetary value).

Variable	Frequency	Percentage
Monetary Value of Annual Total Yield		
N50, 000 - N150,000	9	2.5
N151, 000 – N250,000	33	9.3
N251, 000 – N350, 000	93	26.3
N351, 000 – N450, 000	30	8.5
N451, 000 and Above	189	53.4

Source: Author's Field Survey (2024).

Statement of Hypothesis

H₀: Socio-economic characteristics of the farmers have no influence on modal choice in the study area.

The golden rule is that if critical p-value is lower than the 0.05 level of significance then the null hypothesis is rejected and the alternative hypothesis is accepted. The regression model in Table 4 was used to predict the influence of farmers' socio-economic characteristics on choice of transport means used for distribution of agricultural produce by farmers in the study area. The result shows that five out of the six variables (socioeconomic characteristics) have positive influence on the transport means used by the farmers for distributing their agricultural produce. Gender with value of ($\beta = .848$) has the greatest impact on the means of transportation used for distribution of agricultural produce by the rural farmers in Osun State. This is followed by level of education ($\beta = .540$), age ($\beta = .406$), income ($\beta = .195$) and family size ($\beta = .130$) having the least influence. However marital status was insignificant with age ($\beta = .034$) The R^2 for this model indicate that 64.6 percent of the variation in choice of means of transportation used by farmers for distribution of agricultural produce are explained by gender, level of education, age, income and family size.

Gender can influence transport modal choice decision. Decision on usage and ownership of transport mode are exclusively vested in the hands of men. Simeon *et al.*, (2020) affirmed the

fact that ownership of modes of transport, modal choice and distribution decisions are predominantly done by men. Also, age was also found to have a significant effect on mode choice selection by farmers in the study area. Farmers that are active and are within the productive age group tend to be agile and experienced in farming. This fact will likely influence their modal choice of transportation in the study area because majority of farmers will be producing agricultural produce at commercial qualities and at large scale. Hence, the decision to move farm produces to markets in quick and effective succession in order to forestall the perishability of farm produce. This is supported by Alfred (2018) that reveals that farmers in the productive age bracket will tend to own and make use of motorized transportation mode with high carriage capacity.

In the same vein, educational level of the rural farmers' influences transport mode choice selection. This is supported by the finding of Egbetokun (2012) that opined that farmers with high level of education will tend to make best modal choices in the distribution of their farm produce from areas of low utility to areas of high utility and from farm to the market. Furthermore, farmers with high educational level may not lack notice of recent development in areas of making appropriate transportation decisions (modal choices) and this will in turn increase their agricultural produce distribution activities. Hence, impacting positively on revenue generation and boosting of agricultural productivity level of farmers. This is further supported by Abimbola et al., 2015 which states that an educated farmer will prefer the usage of motorized transport instead of head portorage for distribution activities where necessary.

Farmers' income also significantly influences farmer's choice when it comes to selecting the means of transportation that will be used in distributing their farm produce. According to (Falola& Heaton, 2008), transport plays a significant role in the structure of food production and easy distribution of farm produce to the market and enhances level of rural farmers' incomes. Hence, farmers' with higher income will be stimulated to make more trips far away from markets where they encounter low patronage to markets where their produce command more utilities and value. Hence, the financial capabilities of farmers will spur farmers to carry out maintenance of their own transport vehicles; farmers will be able to buy new vehicles and it will also allow farmers to be able to make appropriate modal choices as

regards the means of transport available to them. This finding is supported by Ajiboye&Afolayan (2009) which show that improved farmers' income tends to stimulate vehicle ownership and maintenance culture.

Findings in Table 4 further shows that family size is an indication that farmers' have a ready source of family labour on the farm. Farmers with large family size will tend to make decisions on modal choices in the distribution of farm produce, movement of work force from settlement to farm stead and from farm stead to settlements and markets. This is in consonance with the findings of Usman (2014) that giving birth to more children may be a ready source of family help on the farm in the long run agriculturally. However, the result showed that marital status does not have significance on the choice of means of transport used by the farmers in distributing their agricultural produce.

Table 4: Coefficients of the of the Influence of Farmers' Socio-economic Characteristics on Choice of Means of Transport Used for Distribution of Agricultural Produce in the Study Area.

Model		Unstandardized		Standardized	t	Sig.
		Coefficients		Coefficients		
		B	Std. Error	Beta		
1	(Constant)	.330	.278		1.186	.236
	Age	.202	.035	.406	5.865	.000
	Gender	1.063	.106	.848	10.033	.000
	marital status	-.130	.126	-.034	-1.031	.303
	Level of education	-.309	.051	-.540	-6.075	.000
	family size	.120	.039	.130	3.053	.002
	Income	-.090	.024	-.195	-3.737	.000

a. Dependent Variable: modal choice

Source: Author's Field Survey, (2023).

4. CONCLUSION AND RECOMMENDATIONS

This study has examined socio-economic characteristics of farmers on modal choice in the study area. The study was conducted in all the nine farm settlements in Osun State. Purposive sampling techniques was employed, five hundred and five (505) copies of the questionnaire were randomly administered on the farmers in the farm settlements. The instrument for data collection was the questionnaire and the interview schedule. The questionnaire was divided into sections to elicit information on conditions of access roads and farmers performance (income) in the studied area. While the uneducated respondents were interviewed based on the questions contained in the questionnaires.

Data generated were analyzed using both descriptive and inferential statistics. Descriptive statistics such as frequencies and percentages. While inferential statistics such as multiple regression analysis was used to examine socio-economic characteristics of farmers on transport modal choice selection in the studied area.

The study revealed that socio-economic characteristics of the farmers has a significant effect on modal choice selection by the rural farmers in the study area with $R = 0.840$, $R \text{ square} = 0.646$, $F\text{-value} = 105.725$, significant at $p < 0.05$. However, only five socio-economic characteristics were significant; age of the farmers (40.6%) family size made the least significant contribution of 13.0% while marital status was insignificant (-0.034). Furthermore, findings from the study revealed that farmers have embraced the use of motorized transport as available and mostly used means of transportation for movement from settlement to farm and from farm to settlements and in moving of farm produce to the market which could be as a result of nearness of most of the settlements to major road networks.

The study concluded that the use of motorized means of transport cannot be over emphasized in rural areas as most of the rural farmers still rely predominantly on it. Also, road conditions

influences farmers' income and productivity. Based on the findings of the study, the following recommendations were made:

- The State government should ensure the adequate provision of good roads in the study area and improve on the existing ones to enhance distribution of agricultural produce.
- Regular maintenance of the roads such as clearing of road edges, provision of adequate drainage to prevent blockage during wet season should be carried out by the relevant agency in the State to ensure that all existing roads are kept in good condition.
- Osun Rural Access Mobility Programme (O – RAMP) should improve on roads networks connectivity and upgrade them to paved road surfaces where they are strategically needed within the farm settlements

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INVESTIGATING EXPORT-LED GROWTH HYPOTHESIS: A COMPARISON OF TWO COINTEGRATION MODELS

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ABSTRACT

The study investigated the Export-Led Growth Hypothesis in Nigeria using two cointegration models - Engle-Granger cointegration and error correction model, and the autoregressive distributed lag (ARDL) approach. Quarterly time series data from 1988 to 2022 was analyzed, including variables like Gross Domestic Product (GDP), exports, imports, gross fixed capital formation, and labor force. The cointegration tests revealed a long-run relationship among the variables, and the long-run coefficients from the ARDL model suggested that exports and labor are significant predictors of GDP changes at the 1% level. The stability of the models was confirmed through CUSUM recursive tests. Comparing the results, the ARDL approach was found to be more consistent with the Toda-Yamamoto Granger causality analysis, which revealed a bidirectional causality between GDP and exports, thus confirming the validity of the Export-Led Growth hypothesis in Nigeria. The study recommends that statisticians and econometricians should be encouraged to use the ARDL model, as the Engle-Granger approach can lead to misleading conclusions. The findings highlight the importance of exports and labor in driving economic growth in Nigeria and provide valuable insights for policymakers to design effective strategies to promote export-led growth.

Keywords: Export-Led Growth, Cointegration, ARDL Model, Granger Causality, Nigeria

BACKGROUND TO THE STUDY

Economic growth means an increase in the productive capacity of an economy over time to bringing about rising levels of national production and income (Sheehan *et al.*, 2019). Every country (developed and the developing) is concerned about its rate of economic growth. Economic experts, policymakers, public, and private sectors work ceaselessly towards attaining economic growth by the use of development models and policies. In this study, the export-led growth in Nigeria is examined.

According to export-led growth strategists, the growth of an emerging nation is largely dependent on the capacity of the nation to produce goods and services in which they have comparative advantage for its local needs and ultimately for export, and import the commodities in which they have comparative disadvantage, i.e. high internal opportunity cost (Nduka, Chukwu, Ugor&Nwakaire, 2018). In affirming the relevance of international trade in Africa, Kofi Annan, the former UN Secretary General said, "Africa's growth out of

poverty will depend on its developing greater linkages with the world economy through trade.”

Aim and Objectives of the Study

The aim of the study is to Investigate Export-Led Hypothesis by comparing two co-integration models.

The specific objectives of the study are to:

4. Examine the relationship between export, import, labour, capital and gross domestic product
5. Identify the changes in GDP that can be attributed to export, import, labour and capital
6. Examine the robustness between Engle-Grangers model and autoregressive distributed lag (ARDL) model in the study of export-led growth on Nigeria.

LITERATURE REVIEW

The Effects of Export on Economic Growth

In the last decade, there has been a surprising and impressive resumption of activity in the economic growth literature triggered by the endogenous growth theory, which has led to an extensive inventory of models that stressed the importance of trade in achieving a sustainable rate of economic growth. These models have focused on different variables such as the degree of openness, exchange rate, tariffs, terms of trade and export performance, to verify the hypothesis that open economies grow faster than closed ones (Edwards, 2019).

The Empirical Literature Review on Export-Led Growth Hypothesis in Nigeria

In Nigeria, some authors had examined the performance of foreign trade and economic growth. For instance, Egwaikhide (2021) examines the qualitative effects of export (non-oil) expansion on Nigeria’s economic growth over the period, 1960 to 1983. Based on simulation experiment, he observes among others, that a 75 per cent rise in non-oil export led to 1.4 per

cent increase in real GDP. He concluded that there is need to promote export in order to enhance GDP growth in Nigeria.

Ogbokor (2017) investigated the macroeconomic impact of oil exports on the economy of Nigeria. Utilizing the popular OLS technique, he observed that economic growth reacted in a predictable fashion to changes in the regressors used in the study. He also found that a 10% increase in oil exports would lead to 5.2% jump in economic growth. He concluded that export oriented strategies should be given a more practical support.

Olusegun (2019) examines the export-led growth hypothesis for the period, (1970-2006), he uses five important variables, GDP, export value, import value, exchange rate, labour force and gross capital formation. He investigated both causal and dynamic long run nature of the variables using ARDL and Toda-Yamamoto causality test. The findings showed that there is a bidirectional relationship between output and export hence, a support for export-led growth for Nigeria.

The Analytical Framework

We base our empirical model on the Feder (2021) model. Starting with a general neoclassical Aggregate Production Function:

$$Y_t = A_t K_t^\alpha L_t^\beta$$

where, Y_t = aggregate production of the economy at time t , A_t = level of Total Factor Productivity (TFP), K_t = capital stock at time t , L_t = stock of labour at time t . According to Feder (2021) the impact of exports on economic growth possibly operates through total factor productivity (A_t). In order to investigate if and how exports affect economic growth through changes in TFP, we assume that TFP can be expressed as a function of exports X_t , and other exogenous factors C_t , thus:

Engle Grangers Cointegration and Error Correction Approach

The link between cointegration and error correction model stems from the Granger representation theorem (Engle and Granger, 2017). The theorem states that two or more integrated time series that are cointegrated have an error correction representation, and two or more time series that are error correcting are cointegrated.

The Autoregressive Distributed Lag (ARDL) Cointegration Approach

Following Pesaran *et al.*, (2021) as summarized in Choonget *al.*, (2015), we apply the bounds test procedure by modeling equation (2.4) as general vector autoregressive (VAR) model of order p in z_t :

$$z_t = c_0 + \alpha t + \sum_{i=1}^p \eta_i z_{t-i} + \varepsilon_t, t=1, 2, 3 \dots T \quad (2.8)$$

With c_0 representing a $(k+1)$ -vector of intercepts and α denoting a $(k+1)$ -vector of trend coefficients. z_t is the vector of variables y_t and x_t respectively. y_t is the dependent variable defined as LY_t , and x_t is the vector matrix which represent a set of explanatory variables (as already defined) with a multivariate independently and identically distributed (*iid*) zero mean error vector $\varepsilon_t = (\varepsilon_{1t}, \varepsilon'_{2t})'$ and a homoscedastic process.

METHODOLOGY

Data on GDP (Y_t), exports (X_t), oil exports (OX_t), imports (M_t), total labourforce (L_t) and Gross fixed capital formation (K_t) for Nigeria were used for the study periods 1988 - 2022. The following will be followed, first, since both cointegration test and Toda-Yamamoto Granger Causality test require certain stochastic structure of the time series, stationary properties of the time series data was investigated using the Phillips Perron (PP) tests in order to determine the order of integration of each time series.

Model Specification

In order to estimate the Export-led growth variable by the Engle-Granger Cointegration, the first step suggested by Engle and Granger (2017) in cointegration test was to subject the time series individually to unit root tests. This research employed the method of Phillip Perron (PP) test. The following model will be estimated if the variables in the equation are integrated of the order using ordinary least square method, which is:

$$LY = \beta_0 + \beta_1 \ln X_t + \beta_2 \ln M_t + \beta_3 \ln L_t + \beta_4 \ln K_t + \varepsilon_t$$

Where, \ln : natural log, Y_t : gross domestic product, X_t : exports, M_t : imports, L_t : Labour force and K_t : capital and $\beta_0, \beta_1, \beta_2, \beta_3, \text{ and } \beta_4$ are the parameters known as the intercept and slope coefficients, and ε_t is the random disturbance terms. A long-run relationship is established, if linear combination of these variables in their levels produces a residual variable that is integrated of order zero. Then, cointegration is established and the model is estimated using the error correction model as given below

$$\Delta \ln Y = \beta_0 + \beta_1 \Delta \ln X_t + \beta_2 \Delta \ln M_t + \beta_3 \Delta \ln L_t + \beta_4 \Delta \ln K_t + \varepsilon_{t-1} + u_t$$

DATA ANALYSIS

In this section, empirical analysis of export-led growth for the quarterly data between periods 1988 to 2022 was carried out explicitly. An in-depth analyses and explanations to this period were given as follows.

Unit Root Test Results

In order to perform Johansen Cointegration test, the series have to be stationary. To investigate whether a series is stationary or not, unit root test was conducted using Phillips-Perron test statistic at level and at first difference of each series on the condition that the null hypothesis is non-stationary, so rejection of the unit root hypothesis supports stationarity.

The hypothesis tested is:

$H_0: \gamma = 1$ (unit root is present)

$H_1: \gamma \neq 1$ (unit root is not present)

$\alpha = 0.05$

Test statistic

$$\tilde{t} = \frac{S}{S_{Tm}^2} \hat{t}_p - \frac{0.5(S_{Tm}^2 - S^2)T}{S_{Tm} \sqrt{\sum_{t=2}^T y_{t-1}^2}}$$

Critical region: Reject H_0 if, p-value < 0.05 for rejection of hypothesis of a unit root at 5% significance level

Table 4.2: Results of Phillips-Perron Test at Level (Intercept but no trend)

Variables	Test Statistics	Critical Value (5%)	P-Value	Decision (order of integration)
lnY	-0.406039	-2.951125	0.8971	I(0)
lnX	-1.295222	-2.951125	0.6204	I(0)
lnM	-0.645356	-2.951125	0.8471	I(0)
lnL	0.709893	-2.951125	0.9906	I(0)
lnK	1.053112	-2.951125	0.9962	I(0)

ln: natural log, Y: gross domestic product, X: export, M: import L: labour K: gross fixed capital formation.

Table 4.3: Results of Phillips-Perron Test at First Difference
(Intercept but no trend)

Variables	Test Statistics	Critical Value (5%)	P-Value	Decision (order of integration)
D(lnY)	-5.346198	-2.954021	0.0001	I(1)
D(lnX)	-6.959399	-2.954021	0.0001	I(1)
D(lnM)	-5.000943	-2.954021	0.0003	I(1)
D(lnL)	-4.568404	-2.954021	0.0009	I(1)
D(lnK)	-4.958945	-2.954021	0.0003	I(1)

D: first difference L: natural log, Y: gross domestic product, X: exports, M: imports, L: labour K: gross fixed capital formation.

Conclusion: Table 4.2 and 4.3 showed the results of unit root test. The results revealed that time series were non-stationary at levels. However, table 4.3 indicated that the series became

stationary at 1st difference [I(1)]. Phillips-Perron unit root test revealed that errors had constant variance and were statistically independent. Therefore, cointegration test can be applied on these variables, as supported by Shahzadi and Chohan, (2021).

Determination of Lag Length

The determination of lag length is a trade-off between the curses of dimensionality and abbreviates models, which are not appropriate to indicate the dynamic adjustment.

If the lag length is too short, autocorrelation of the error terms could lead to apparently significant and inefficient estimators. Therefore, one would receive wrong results.

Table 4.4: VAR Lag Selection Criteria by Schwarz Information Criterion

Number of lag	lnY	lnX	lnM	lnL	lnK	system
Lag 1	-0.007	1.416	0.905	-4.497	0.538	-4.558
Lag 2	0.070	1.352	0.852	-4.031	0.832	-3.148
Lag 3	0.327	1.621	1.082	-3.675	1.098	-2.707
Lag 4	0.415	1.931	1.295	-4.315	1.404	-2.666

Table 4.4 above reported the optimal lag length of one (i.e $p=1$) out of a maximum of 4 lag lengths considered.

Cointegration Test

Cointegration tests were performed using Engle-Granger approach and autoregressive distributed lag (ADRL) bound test approach.

Engle and Granger Co-integration Analysis

The regression of a nonstationary time series on another nonstationary time series may produce a spurious regression. Therefore, the first step suggested by Engle and Granger (2017) in cointegration test was to subject the time series individually to unit root tests. If Phillips-Perron unit root test is applied and the variables in each equation were integrated of the same order, that is, if they were I(1) after the first differences had been taken and each

series became stationary. The second step is to apply the OLS method to estimate the regression of each of the equation under investigation. That is

$$\ln Y = \beta_0 + \beta_1 \ln X_t + \beta_2 \ln M_t + \beta_3 \ln L_t + \beta_4 \ln K_t + \varepsilon_t$$

where, \ln : natural log, $[Y_t]$: gross domestic product $[X_t]$: exports, $[M_t]$: imports, $[L_t]$ Labour force and $[K_t]$: capital and $[\beta_0, \beta_1, \beta_2, \beta_3, \text{ and } \beta_4]$ are the parameters known as the intercept and slope coefficients, and $[\varepsilon_t]$ is the random disturbance terms.

Table 4.5: Results of Phillips-Perron Test of the Residuals

Residual	T-ADF	5%	P-Value
Model	-3.134860	-1.951000	0.0027

Table 4.5 showed that the value of t-statistic was -3.134860 less than -1.951000 at 5% level of significant and therefore, indicated that the residual series were stationary at level, then, estimates of the model can be performed using error correction mechanism.

Table 4.6: Estimated Short-run Dynamics by Engle-Granger Error Correction Approach for E

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.030394	0.032110	0.946556	0.3526
D(lnX)	0.277917	0.058667	4.737221	0.0001
D(lnM)	0.168012	0.076343	2.200747	0.0368
D(lnL)	3.349680	0.949461	3.527979	0.0016
D(lnK)	-0.045515	0.084302	-0.539911	0.5939
ECM1(-1)	-0.379958	0.154702	-2.456056	0.0210
R-squared	0.721885	Mean dependent var		0.190878
Adjusted R-squared	0.668402	S.D. dependent var		0.181215
S.E. of regression	0.104352	Akaike info criterion		-1.514731
Sum squared resid		Schwarz criterion		-1.239906

	0.283123		
Log likelihood	30.23570	Hannan-Quinn criter.	-1.423634
F-statistic	13.49732	Durbin-Watson stat	1.439260
Prob(F-statistic)	0.000002		

Table 4.6 is the results of short-run dynamics of the system. The ECM1(-1) coefficients take negative sign and was significant at 5 percent level of significant. The coefficients values of -0.38 of the error correction terms indicated that the deviation from the long-run term growth rate in GDP will be corrected by 0.38 percent by the coming year.

The values of export, import, and labour were significant in causing changes in GDP on the short-run, whereas, capital was not significant.

Autoregressive Distributed Lag (ARDL) Bound Test for Cointegration

The first step in the ARDL bounds testing approach is to estimate the following equations

$$\Delta \ln Y_t = \lambda_0 + \lambda_1 \ln Y_{t-1} + \lambda_2 \ln K_{t-1} + \lambda_3 \ln L_{t-1} + \lambda_4 \ln M_{t-1} + \lambda_5 \ln X_{t-1} + \sum_{i=1}^p a_i \Delta \ln Y_{t-i} + \sum_{i=1}^p b_i \Delta \ln X_{t-i} + \sum_{i=1}^p c_i \Delta \ln M_{t-i} + \sum_{i=1}^p d_i \Delta \ln L_{t-i} + \sum_{i=1}^p f_i \Delta \ln X_{t-i} + \varepsilon_t$$

Where ε_t are white noise errors, Δ is the first difference operator and p is the optimal lag length. All variables are in natural logarithms. The parameters λ_i , $i=1,2,3,4$, and 5, function as long-run multipliers, while the a_i, b_i, c_i, d_i, f_i parameters function as the short-run dynamic coefficients of the underlying ARDL model.

We conduct a Wald test (F-Statistic) by imposing restrictions on the estimated long-run coefficients.

Hypothesis to be testes are

$$H_0 : \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = 0 \text{ (no long-run relationship)}$$

H_1 : At least one of the λ_i is different from zero (a long-run relationship exists)

Test statistic

$$F = \frac{(Rb - q)'[R(X'X)R']^{-1}(Rb - q)/J}{S^2} \sim F(j, (n - k))$$

Decision rule:

1. Reject H_0 of no cointegration when the F-value exceeds the upper critical bounds value
2. Do not reject H_0 if the F-value is lower than the lower bounds
3. The decision about cointegration is inconclusive, if the calculated F-statistic falls between the lower and upper-bound critical values.

Table 4.7: Results from Bounds Tests for Cointegration Analysis with no Intercept and no Trend

Test-statistic	5% Critical values		10% Critical values	
F-statistics	I(0)	I(1)	I(0)	I(1)
3.736326	2.26	3.48	1.90	3.01

Conclusion: The results of table 4.7 suggested the existence of cointegration at both 5% and 10% levels of significance since 3.736 was above the upper critical bound values of 3.48 and 3.01 respectively. This implied that GDP, exports, imports, labour and capital had long-run relationship jointly.

Estimation of Long-run Coefficients

Since long run relationship were established which indicated the existence of long-run cointegration relationship between variables, the following long-run models were estimated:

$$\ln Y_t = \alpha + \sum_{i=1}^p \phi_i \ln Y_{t-1} + \sum_{i=0}^{q_1} \theta_i \ln X_{t-1} + \sum_{i=0}^{q_2} \delta_i \ln M_{t-1} + \sum_{i=0}^{q_3} \xi_i \ln L_{t-1} + \sum_{i=0}^{q_4} \tau_i \ln K_{t-1} + u_t$$

Table 4.8: Model Selection Result Based on AIC, SIC and HQIC

Model	Lag Length	AIC	SIC	HQIC
ARDL(1,1,1,1,1)	1	-1.693402	-1.23559	-1.541574
ARDL(1,2,1,1,2)	2	-1.68804	-1.132949	-1.505619
ARDL(1,2,1,1,3)	3	-1.641498	-1.034312	-1.447254

The lags selected based on SIC were 1, 2 and 3 lags for both equation 2.4 and equation 2.5 respectively. However, at various lags, Eviews 7.2 suggested three different ARDL models whereas, at the three different lags selected, ARDL(1,1,1,1,1) was the optimal. Therefore, ARDL(1,1,1,1,1) was considered to be the best model based on AIC, SIC and HQIC results of the ordinary least square estimated.

Table 4.9: Estimated Long Run Coefficients using the ARDL (1,1,1,1,1)

Approach				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.330072	2.620896	-0.507488	0.6169
lnX	0.352487	0.065888	5.349788	0.0000
lnM	0.015569	0.097204	0.160168	0.8742
lnL	3.461032	0.925439	3.739883	0.0011
lnK	0.084406	0.089960	0.938257	0.3583
R-squared	0.998589	Mean dependent var		7.877597
Adjusted R-squared	0.998012	S.D. dependent var		2.053517
S.E. of regression	0.091557	Akaike info criterion		-1.693402
Sum squared resid	0.184419	Schwarz criterion		-1.235359
Log likelihood	37.09443	Hannan-Quinn criter.		-1.541574
F-statistic	1730.290	Durbin-Watson stat		1.958898

Prob(F-statistic) 0.000000

Table 4.9 was the results after the estimation of the model and it revealed that in table 4.9 the adjusted R-squared is very high indicating that the overall goodness of the model was satisfactory. The adjusted R-squared showed that about 100 percent variation in GDP was explained by regressors in the model. The F-statistic measuring the joint significance of all regressors in the model was statistically significant at 1 percent level. Similarly, the Durbin Watson statistic was about 2 > R-squared of 0.99 and higher than the upper value of 1.730 signifying that the ARDL result was void of spurious regression problem and autocorrelation respectively.

Table 4.10: Error Correction Representation for ARDL (1,1,1,1,1) Model
with ΔLY as a Dependent variable

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.019641	0.047067	0.417299	0.6809
D(lnX)	0.344033	0.067453	5.100328	0.0001
D(lnM)	0.009103	0.073704	0.123513	0.9029
D(lnL)	3.420338	0.942461	3.629155	0.0017
D(lnK)	0.106630	0.078556	1.357384	0.1898
ECM1(-1)	-1.041858	0.400059	-2.604263	0.0170
R-squared	0.832046	Mean dependent var	0.194826	
Adjusted R-squared	0.748069	S.D. dependent var	0.182807	
S.E. of regression	0.091756	Akaike info criterion	-1.667945	
Sum squared resid	0.168383	Schwarz criterion	-1.159111	
Log likelihood	36.85315	Hannan-Quinn criter.	-1.502078	
F-statistic	9.908026	Durbin-Watson stat	1.921093	
Prob(F-statistic)	0.000009			

Models Diagnostic Checking

The models that are used in this research, the estimates of the short-run dynamics are further tested with the diagnostic tests of Normal Distribution, Serial Correlation, and Heteroskedasticity to be void of model misspecifications.

The Hypothesis tested here were

1. H_0 : Residuals are not serially correlated
 H_1 : Residuals are serially correlated
2. H_0 : Residuals are homoskedastic
 H_1 : Residuals are heteroskedastic
3. H_0 : Residuals are normally distributed
 H_1 : Residuals are not normally distributed

Decision criteria: Reject H_0 if P-value < 0.05 significant value otherwise H_0 is retained

Table 4.11: Diagnostic Results of the Residual Test for the Models

Approch	Model	Breusch-Godfrey		Breusch-pagan		Jacque-Bera test	
		Correlation LM Test		GofreyHeteroskedasti		for Normality	
				city Test			
		Obs R-	P-	Obs R-	P-		
		square	Value	square	Value	JB-value	value
Engle-							
Grangers							
Approach	Equation 4.3	5.1394	0.0234	16.0268	0.0068	0.4079	0.8155
ARDL							
Model	Equation 4.7	0.0049	0.9443	14.4449	0.1074	0.5422	0.7625

Table 4.11 indicated results of the model diagnostic tests of the residuals for serial correlation, heteroskedasticity and normality tests. The results showed that all the models

considered using autoregressive distributed lag (ARDL) approach pass the entire test that characterized a good ordinary least squared method, however, the Engle and Grangers approach, failed the serial correlation test which was one of the desirable characteristic of a good model.

CONCLUSION

The study examined the validity of export-led growth in the case of Nigeria economy comparing two methods of estimations, Engle-Granger's cointegration and error correction model and the Autoregressive Distributed Lag (ARDL) model. The results obtained from the methods were compared for consistence with the results of Johansen cointegration, and the Toda-Yamamoto causality test for the period 1988 to 2022. To assess the impact of export in increasing the gross domestic product, the work was based on the empirical model of Feder (2021) model.

Based on the findings of the study, it was concluded that,

- The variables under consideration, GDP, export, import, labour and capital were cointegrated jointly and therefore, long-run relationship exist between them.
- The estimates from Engle and Granger cointegration and error correction models were not void of serial correction which is one of most serious problem in ordinary least square regression estimate.
- Autoregressive distributed lag models were more robust in capturing the information contained in the data compared to Engle and Granger cointegration and error correction models.
- Export led growth hypothesis was valid in the case of Nigeria.

Recommendations

Based on the preceding conclusions on the results of the analysis, the following were hereby recommended that:

4. Government should diversify its economy to maximize its economy potential which in turn will bring about economic growth.
5. Government should invest income from oil sector for the development of non-oil sector of the economy, as that will greatly boost the Gross Domestic Product (GDP) which will bring about growth and development in the economy.
6. The use of autoregressive distributed lag (ARDL) model should be encouraged among Statistician and Econometrician since results from Engle and Granger cointegration and error correction model could still lead to misleading.

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SOLUTION AND NUMERICAL COMPARATIVE OF LINEAR VOLTERRA INTEGRAL EQUATIONS OF SECOND KIND

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ABSTRACT

In this paper, we consider linear Volterra integral equations and adopt the series solution method for the exact solutions of the equations. We further use the Variational iteration method and the Adomian decomposition method and we observed the powerful and efficiency of the methods using numerical comparison.

Keywords: Variational Iteration Method, Series Solution Method, Adomian Decomposition Method, Leibniz Rule of Differentiation, MATLAB

1. INTRODUCTION

Numerous challenges pertaining to both linear and non-linear Volterra integral equations have been addressed, and several solutions can be located in existing literature [1, 2, 3, 7], accompanied by detailed explanations. This study focuses solely on linear Volterra integral equations of the second kind. We furnish solutions for these equations and subsequently evaluate their effectiveness

1.1 LINEAR VOLTERRA INTEGRAL EQUATION

Linear Volterra integral equation is the integral equation of the form

$$u(x) = f(x) + \lambda \int_0^x k(x,t)u(t)dt \quad (1)$$

Where $k(x,t)$ is called a kernel and $u(x)$ is the unknown to be determined, when the unknown $u(x)$ appears in the integral sign and in the outside of the integral sign the equation is said to be a Volterra integral equation of the second kind.

2. THE METHODS

In this paper, we employed three techniques to address the given problems. The series solution method was utilized to obtain the precise solution, whereas the Adomian Decomposition Method (ADM) and Variational Iteration Method (VIM) were employed for comparative analysis with the closed-form solution (exact solution).

2.1 The Series Solution Method

The $u(x) = \sum_{n=0}^{\infty} a_n x^n$ will be substituted in (1) as shown below

$$\sum_{n=0}^{\infty} a_n x^n = T(f(x)) + \lambda \int_0^x k(x,t) \left(\sum_{n=0}^{\infty} a_n t^n \right) dt \quad (2)$$

Where $T(f(x))$ is the Taylor's series of $f(x)$ then the term of the form t^n in the right hand side of (2) will be integrated and the coefficients $a_n, n \geq 0$ of the like power of x will be collected. Then the recurrence relation a_n will be established for the coefficients.

The Adomian decomposition method involves splitting the unknown function of a given integral equation into an infinite series of components, as outlined by the decomposition series below:

$$\sum_{n=0}^{\infty} u_n(x) = f(x) + \lambda \int_0^x k(x,t) \left(\sum_{n=0}^{\infty} u_n(t) \right) dt$$

$$u_0(x) + u_1(x) + u_2(x) + \dots = f(x) + \lambda \int_0^x k(x,t) [u_0(t) + u_1(t) + u_2(t) + \dots] dt \quad (3)$$

Where $u_0(x)$ is the all terms in the right hand side of (3) that are not inside the integral sign, thus we have:

$$\begin{aligned} u_0(x) &= f(x) \\ u_{n+1}(x) &= \lambda \int_0^x k(x,t)u_n(t)dt, \quad n \geq 0 \end{aligned}$$

Equivalently

$$\begin{aligned} u_1(x) &= \lambda \int_0^x k(x,t)u_0(t)dt, \quad n = 0 \\ u_2(x) &= \lambda \int_0^x k(x,t)u_1(t)dt, \quad n = 1 \\ u_3(x) &= \lambda \int_0^x k(x,t)u_2(t)dt, \quad n = 2 \quad \text{and so on} \end{aligned}$$

By substituting the terms $u_0(x), u_1(x), u_2(x) \dots$ in the series $\sum_{n=0}^{\infty} u_n(x) = u_0(x) + u_1(x) + \dots$ the solution of the given problem will be obtained.

2.3 Variational Iteration Method (VIM)

To use variational iteration method for solving Volterra integral equations, it's necessary to convert the integral equations to its equivalent integro-differential equations, that is an equation that contains differential and integral operators in the same equation.

The i th order integro-differential equation is of the form below:

$$u^{(i)}(x) = f(x) + \int_0^x k(x,t)u(t)dt \quad 2.3.1$$

Where $u^{(i)}(x)$ is the i th order derivative of the unknown function $u(x)$ and $u(0), u'(0), u''(0), \dots, u^{n-1}(0)$ are the initial conditions, the correction functional for the integro-differential equation (2.3.1) above is as follow

$$u_{n+1}(x) = u_n(x) + \int_0^x \lambda(\xi) \left(u_n^{(i)}(\xi) - f(\xi) - \int_0^\xi k(\xi, r) \tilde{u}_n(r) dr \right) d\xi, \quad n \geq 0$$

The Lagrange multiplier $\lambda(\xi)$ is depend upon the order derivative of the unknown function $u(x)$ as shown below

$$u'(x) + f(u(\xi), u'(\xi)) = 0, \quad \lambda(\xi) = -1$$

$$u'' + f(u(\xi), u'(\xi), u''(\xi)) = 0, \quad \lambda(\xi) = \xi - x$$

$$u'' + f(u(\xi), u'(\xi), u''(\xi), u'''(\xi)) = 0, \quad \lambda(\xi) = \frac{1}{2!}(\xi - x)^2$$

In general

$$u^{(n)} + f(u(\xi), u'(\xi), u''(\xi), u'''(\xi), \dots, u^{(n)}(\xi)) = 0,$$

$$\lambda(\xi) = (-1)^n \frac{1}{(n-1)!} (\xi - x)^{(n-1)}$$

3.0 Solution of the problems

Problem 1

Solve $u(x) = 1 + x + \int_0^x (x-t)dt$ (1)

3.1 Using Series Solution Method

Upon substituting $u(x) = \sum_{n=0}^{\infty} a_n x^n$ in (1) above and solve we get the recurrence relation for

the coefficient a_n as $a_n = \frac{a_{n-2}}{n(n-1)}, \quad n \geq 2$ with $a_0 = a_1 = 1$

$$u(x) = 1 + x + \sum_{n=2}^{\infty} \frac{a_{n-2}}{n(n-1)} x^n$$

$= e^x$ is the exact solution of the (1)

3.2 Using Adomian Decomposition Method (ADM)

$$u_0(x) = 1 + x$$

$$u_1(x) = \frac{1}{2!}x^2 + \frac{1}{3!}x^3$$

$$u_2(x) = \frac{1}{4!}x^4 + \frac{1}{5!}x^5$$

$$u_3(x) = \frac{1}{6!}x^6 + \frac{1}{7!}x^7$$

$$u(x) = 1 + x + \frac{1}{2!}x^2 + \frac{1}{3!}x^3 + \frac{1}{4!}x^4 + \frac{1}{5!}x^5 + \frac{1}{6!}x^6 + \frac{1}{7!}x^7 + \dots$$

3.3 Using Variational Iteration Method (VIM)

Differentiating (1) using Leibniz rule we get

$$u'(x) = 1 + \int_0^x u(t) dt \text{ and}$$

$$u_0(x) = 1$$

$$u_1(x) = 1 + x + \frac{1}{2!}x^2$$

$$u_2(x) = 1 + x + \frac{1}{2!}x^2 + \frac{1}{3!}x^3$$

$$u_3(x) = 1 + x + \frac{1}{2!}x^2 + \frac{1}{3!}x^3 + \frac{1}{4!}x^4 + \frac{1}{5!}x^5$$

Problem 2

$$\text{Solve } u(x) = 1 - \int_0^x u(t) dt \quad (2)$$

3.4 Using Series Solution Method

Substituting $u(x) = \sum_{n=0}^{\infty} a_n x^n$ in (2) we get the recurrence relation for a_n as

$$\begin{aligned} a_n &= -\frac{a_{n-1}}{n}, \quad n \geq 1 \text{ with } a_0 = 1 \\ u(x) &= 1 - \sum_{n=1}^{\infty} \frac{a_{n-1}}{n} x^n \\ &= e^{-x} \text{ is the exact solution of (2)} \end{aligned}$$

3.5 Using Adomian Decomposition Method (ADM)

$$\begin{aligned} u_0(x) &= 1 \text{ and } \lambda = -1 \\ u_1(x) &= x \\ u_2(x) &= \frac{1}{2!} x^2 \\ u_3(x) &= -\frac{1}{3!} x^3 \\ u(x) &= 1 - x + \frac{1}{2!} x^2 - \frac{1}{3!} x^3 + \dots \end{aligned}$$

3.6 Using Variational Iteration Method (VIM)

Differentiating (2) once using the Leibnitz rule and solve we get

$$u_0(x) = 1$$

$$u_1(x) = 1 - x$$

$$u_2(x) = 1 - x + \frac{1}{2} x^2$$

$$u_3(x) = 1 - x + \frac{1}{2} x^2 - \frac{1}{6} x^3$$

Problem 3

$$\text{Solve } u(x) = 1 - \frac{1}{2}x^2 + \frac{1}{6} \int_0^x (x-t)^3 u(t) dt \quad (3)$$

3.7 Using Series Solution Method

Differentiating (3) using Leibnitz rule we get the recurrence relation for a_n as

$$a_n = \frac{a_{n-4}}{n(n-1)(n-2)(n-3)}, n \geq 4 \text{ with } a_0 = 1, a_1 = 0, a_2 = \frac{-1}{2!} \text{ and } a_3 = 0$$

$$u(x) = 1 - \frac{1}{2!}x^2 + \sum_{n=4}^{\infty} \frac{a_{n-4}}{n(n-1)(n-2)(n-3)} x^n$$

$$= \cos x$$

3.8 Using Adomian Decomposition Method (ADM)

$$u_0(x) = 1 - \frac{1}{2}x^2 \text{ and } \lambda = \frac{1}{6}$$

$$u_1(x) = \frac{x^4}{4!} - \frac{x^6}{6!}$$

$$u(x) = 1 - \frac{1}{2}x^2 + \frac{x^4}{4!} - \frac{x^6}{6!} + \dots$$

3.9 Using Variational Iteration Method (VIM)

Using Leibnitz rule on (3) becomes $u'''(x) = \int_0^x u(t) dt$ with $u(0) = 1$, $u'(0) = 0$, and $u''(0) = -1$

Thus, we get the correction functional

$$u_{n+1}(x) = u_n(x) + \int_0^x \left(\frac{-1}{2}(\xi - x)^2 \right) \left[u_n'''(\xi) - \int_0^x u_n(t) dt \right] d\xi$$

$$u_0(x) = 1 - \frac{1}{2}x^2 \text{ and } \lambda(\xi) = \frac{-1}{2}(\xi - x)^2$$

$$u_1(x) = 1 - \frac{1}{2}x^2 + \frac{x^4}{4!} - \frac{x^6}{6!}$$

$$u(x) = 1 - \frac{1}{2}x^2 + \frac{x^4}{4!} - \frac{x^6}{6!} + \dots$$

4.0 Numerical Results and comparison

Table 4.1: Numerical analysis of problem 1 at the number of iterations n=2. Exact solution=

$$e^x$$

S/N	X	EXACT SOL	ADM	VIM	ERROR (ADM)	ERROR (VIM)
1	0.0	1.000000000	1.000000000	1.000000000	0.000000000	0.000000000
2	0.1	1.105170918	1.105170918	1.105170918	2.50022E-13	2.00899E-11
3	0.2	1.221402758	1.221402758	1.221402756	6.49301E-11	2.60461E-09
4	0.3	1.349858808	1.349858806	1.349858763	1.68314E-09	4.5076E-08
5	0.4	1.491824698	1.491824681	1.491824356	1.70063E-08	3.42086E-07
6	0.5	1.648721271	1.648721168	1.648719618	1.02545E-07	1.65264E-06
7	0.6	1.822118800	1.822118354	1.822112800	4.46105E-07	6.00039E-06
8	0.7	2.013752707	2.013751158	2.013734818	1.54928E-06	1.78894E-05
9	0.8	2.225540928	2.225536366	2.225494756	4.56278E-06	4.61729E-05
10	0.9	2.459603111	2.459591263	2.459496363	1.18485E-05	0.000106749
11	1.0	2.718281828	2.718253968	2.718055556	2.78602E-05	0.000226273

From the above table 4.1, the Adomian decomposition method (ADM) has a minimal error compared to the Variational iteration method (VIM) based on the same number of iterations. Despite the fact that both ADM and VIM converge to close form solution but it implies that ADM converge faster to the exact solution for this particular problem.

Table 4.2: Numerical analysis of problem 2 at the number of iteration n=3. Exact solution

$$= e^{-x}$$

S/N	x	EXACT SOL	ADM	VIM	ERROR (ADM)	ERROR (VIM)
1	0.0	1.000000000	1.000000000	1.000000000	0.000000000	0.000000000
2	0.1	0.904837418	0.904833333	0.904833333	4.0847E-060	4.0847E-06
3	0.2	0.818730753	0.818666667	0.818666667	6.40864E-05	6.40864E-05
4	0.3	0.740818221	0.740500000	0.740500000	0.000318221	0.000318221
5	0.4	0.670320046	0.669333333	0.669333333	0.000986713	0.000986713
6	0.5	0.606530660	0.604166667	0.604166667	0.002363993	0.002363993
7	0.6	0.548811636	0.544000000	0.544000000	0.004811636	0.004811636
8	0.7	0.496585304	0.487833333	0.487833333	0.008751970	0.008751970
9	0.8	0.449328964	0.434666667	0.434666667	0.014662297	0.014662297
10	0.9	0.406569660	0.383500000	0.383500000	0.023069660	0.023069660
11	1.0	0.367879441	0.333333333	0.333333333	0.034546108	0.034546108

From the table 4.2 above, both the Adomian decomposition method and Variational iteration method converge to the exact solution at the same rate.

Table 4.3: Numerical analysis of problem 3 at the number of iteration n=1. Exact solution

$$= \cos x$$

S/N	x	EXACT SOL	ADM	VIM	ERROR (ADM)	ERROR (VIM)
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1	0.0	1.000000000	1.000000000	1.000000000	0.000000000	0.000000000
2	0.1	0.995004165	0.995004165	0.995004165	2.48024E-13	2.48024E-13
3	0.2	0.980066578	0.980066578	0.980066578	6.3464E-11	6.3464E-11
4	0.3	0.955336489	0.955336488	0.955336488	1.62561E-09	1.62561E-09
5	0.4	0.921060994	0.921060978	0.921060978	1.62251E-08	1.62251E-08
6	0.5	0.877582562	0.877582465	0.877582465	9.66126E-08	9.66126E-08
7	0.6	0.825335615	0.825335200	0.825335200	4.1491E-07	4.1491E-07
8	0.7	0.764842187	0.764840765	0.764840765	1.42201E-06	1.42201E-06
9	0.8	0.696706709	0.696702578	0.696702578	4.13157E-06	4.13157E-06
10	0.9	0.621609968	0.621599388	0.621599388	1.05808E-05	1.05808E-05
11	1.0	0.540302306	0.540277778	0.540277778	2.45281E-05	2.45281E-05

From table 4.3 above the Adomian decomposition method (ADM) and the variational iteration method (VIM) converge at the same rate to the exact solution.

5 Conclusions

It was observed that both the Variational Iteration Method and the Adomian Decomposition Method converge to the close form solution (exact solution) if it exist but the efficiency of their convergence depends upon the problem to be solved.

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