GSU, GOMBE-2024

The 33rd Multidisciplinary Academic Conference Proceedings of Mediterranean Research and Publications In Sub-Sahara African Resources for Sustainable Development: Multidisciplinary Approach, Vol. 33 No. 2, 3(December, 2024- Gombe State University, GSU-Gombe, Gombe State, Nigeria.

Pages

101-117

ASSESMENT OF THE ADOPTION OF GREEN BUILDING TECHNOLOGY TECHNIQUES ON WORKERS' PERFORMANCE IN PUBLIC OFFICE BUILDINGS (ABUJA, NIGERIA AS A CASE STUDY)

[1]YUNUSA A.; & [2]ALUMBUGU P. O.

[1]Quantity Surveying Department, Federal Polytechnic Bida, Niger State, Nigeria.

[2]Quantity Surveying Department, Federal University of Technology, Minna, Niger State, Nigeria.

ABSTRACT

Green Buildings (GB) can improve occupant satisfaction, productivity and overall well-being (Quandung *et. al.*, 2020). Poor adoption of GBT has led to poor indoor air quality in building in Nigeria, resulting in negative impacts on occupants' health and productivity (Oyedepo, 2017). The Nigeria Government has made efforts to promote the adoption of Green Building Technology (GBT) for sustainable development by establishing Nigerian Green Building Council (NGBC). In this light, this paper seek to assess effect of the adoption of green building technology on workers' performance in public office buildings in Abuja, Nigeria by adopting the quantitative research approach. Data were collected with the use of structured questionnaires which were administered to 105 purposively sampled respondents who are both construction and non-construction professional public servants. Analysis of data was undertaken with the use of descriptive (Mean Item Score, MIS) and inferential (Spearman Rank correlation analysis) statistical techniques. Findings from the study revealed that the techniques involved in the adoption of GBT for public office buildings most adopted are "Daylighting" (MIS = 4.18) and "Direct solar gain" (MIS = 4.04). The most significant perceived effects of adoption of GBT on performance of workers in public office buildings are "GBT results in a high-quality" (MIS = 4.03) and "GBs help to reduce the demand for new power plants" (MIS = 3.91). There exists a strong, positive and significant relationship between the adoption of Indoor Air Quality/Lighting and workers' satisfaction in public office buildings in Abuja (r = 0.474/0.420; p = 0.000). The study concludes that the impact of GBT on workers' performance in public office buildings in Abuja is significant and can enhance healthier working environment and maximum output for office workers. It was therefore recommended that construction firms to collaborate with other stakeholders to set up mechanism for enhancing the adoption of GBT for public office buildings in Abuja.

Keywords: Green building, Green building technology techniques, workers' performance

INTRODUCTION

Buildings and construction activities are responsible for 40 per cent of global energy use and produce over one third of global greenhouse gas emissions and described technologies

and techniques used in built environments to minimize environmental impacts, such as climate change while ensuring that buildings are able to accommodate the functions they have been designed for, and are comfortable and productive to live and work in (Gibberd, 2020). Rapid acceleration of population and urbanisation places the construction industry on the spot as it demands more physical developments to provide the shelter needs of humans. Hence, the emergence of Green Building Technology (GBT). GBT refers to construction techniques adopted to alleviate the negative effects of construction activities on the natural environment and humans (KeTTHA, 2011).

In Nigeria the adoption of GBT in public offices is hindered by limited awareness, inadequate policies, and high initial costs (Olanrewaju *et al.*, 2018). Consequently, the need for this study, with the view to assessing the performance of public office workers on the adoption of GBT.

GREEN BUILDING

Green building (GB) is a modern construction, with the focus on reducing environmental impact, conserving natural resources and promoting occupants' health, well-being and performance ((USGBC, 2020). The GB certifications is claimed to be capable of providing comfort and improve the performance of employees in workplace (Kshitij, 2020). In this way, green design technologies can enhance Indoor Environment Quality (IEQ), making the environment comfortable and increase the employee performance (Yousef *et al.*, 2016).

GREEN BUILDING TECHNOLOGY TECHNIQUES

According to Daniel and Odoala (2018), Green building technology (GBT) technique is the model used to allow better use of natural resources, safeguard occupant health and safety, improve employee efficiency and minimize waste materials, emissions and environmental degradation. According to (Aher and Pimplikar, 2012), GBT techniques also lays emphasis on four 'R's (reduce, reuse, recycle and renewable) with regards to sound designing, construction and building commissioning without compromising structural durability, indoor pollutant levels, ventilation, building code requirement, or marketability and these includes:

Reduce:- lower quality of building material, resources and embodied energy use
Reuse:- construction materials that are practical and structurally sound and reusable.
Recycle:- recycled materials that are those materials used to build which are recyclable
Renewable:- renewable energy from natural sources

The technique that emphasizes on the four 'R's are called Green techniques. Furthermore, these green techniques can be classified into the following: Structural or civil techniques, electrical (conservation and generation) techniques and Social systems/ techniques. Other special techniques are; grey water management, afforestation, rain water harvesting, passive solar heating and cooling, prevention of soil erosion.

Techniques Involved in the Adoption of GBT for Public Office Buildings

According to Li Xu, Bin Zhou, Chuxin Wang Environmental Art Institute, Environmental Management College of China, Qinhuangdao, China (2015), researched on Design Technology of GB for Environmental Protection and came up with the following as techniques for adoption of GBT:

i. Thermal comfort and humidity; Thermal comfort and humidity have direct link between temperature, humidity and occupant comfort and performance as well as being applicable to buildings that include green technologies as it has an emphasis on low energy and passively cooled and heated buildings.

ii. Indoor air quality and movement; Fresh clean air has important beneficial health and productivity impacts and at least 10-15 litres of fresh air per person per second should be provided in internal environments. Care should be taken that opening windows, air intakes and outlets where fresh air is sourced for interiors are located to avoid pollutants and recirculation of air.

iii. Indoor pollutant source control; Exposure to hazardous chemicals from technology used in the building and from off-gassing from materials and finishes within the building can adversely affect building occupants' health.

iv. Daylighting; Good lighting significantly impacts reading.

v. Views; Occupied spaces must also be physically close (a maximum of 7m) to external windows so that views are experienced.

vi. Glare; Poor artificial lighting and window design can lead to glare which can strain eyes and be uncomfortable. Glare can be avoided through careful lighting design and through controlling the size, location and shading of external fenestration.

vii. Acoustics; Disturbance from external noise and internal acoustics of spaces have been found to be a significant influence on occupant comfort and productivity

viii. External amenity; This includes the quality of landscaping and the availability of comfortable external spaces that can be used as a break from activities undertaken inside buildings.

Comfortable external spaces, particularly landscaped with vegetation, therefore, can make a valuable contribution to occupant wellbeing and comfort.

ix Local control; Green building technologies should provide local control over temperature, lighting and ventilation as this is likely to contribute to occupant satisfaction.

x. Surveys and sensors; The quality of indoor environments can be monitored through surveys and sensors.

This study undertook excessive review of related literature on the techniques involved in the adoption of GBT in the planning, design, construction and management of public office buildings.

WORKERS' PERFORMANCE IN PUBLIC OFFICE BUILDINGS

Workers performance is a fundamental feature of fashioning effective and sustainable work environment. Workers' performance in public office buildings is the extent to which a building meets the needs and expectations of its users, while also supporting the goals and objectives of the organization (Preiser and Vischer, 2005).

BIOPHILIA

Biophilia is the idea that possess any innate tendency to seek connection with nature and other forms of life that promotes a sense of community and belonging which can encourage interaction and bridge the gap between the employees and their work environment (Eric, 1973). Biophilic design, features natural elements such as plants, water, and wood, creates transformative impact on employee happiness and engagement at work, it is not just a design trope; it is a bonafide tool to boost workplace morale and performance (Edward, 1984). A healthy work environment is more than just an appealing phrase, it is a key driver for employee performance and well-being. Prioritizing sustainability, these eco-friendly structures provide a host of benefits that extend beyond reducing carbon footprint, directly impacting worker's day-to-day lives in the office with a strong emphasis on energy efficiency, air quality standards, and consideration for the environment and despite the concept's primarily ecological choices, it can also significantly influence the productivity, health, and happiness of your employees (Zigurat Institute of Technology, 2023).

RESEARCH METHODOLOGY

This research undertakes an extensive literature review to provide the required background information on the effect of adoption of GBT on workers' performance in public office building in Abuja, Nigeria. A quantitative research method was employed by using questionnaire obtain data from professionals within the Abuja, Nigerian construction sector. The techniques for adoption of GBT identified from literature form the basis of the questionnaire design. The study population comprises of the construction and non-construction professionals in public office buildings Abuja. Two government offices with a population size of 487 were considered.

Sampling Method

In order to have a sample that will be representative of the population, the simple random sampling technique was used to select respondent from the sampling frame. Each individual is chosen randomly and entirely by chance, such that each individual has the same probability of being chosen.

Research Population

According to Morenikeji (2006), research population refers to the total number of the considerable population for the research. The population for the research comprised public office workers (construction professionals and non-construction professionals) in two government agencies in Abuja. I was privileged to visit the offices where I liaise with the personnel managers who availed me with their staff nominal list for research purpose. With this, I was able to get total staff strength of both organization as well as identify relevant target respondents. As indicated in table 3.1 below, the total staff strength for both agencies is 487, with a total of 169 construction professionals and 318 non construction professionals.

Table 3.1: Study's Population Size

S/N	Construction Firms	No of Professionals	No of other workers	Total no. of respondents
1	Abuja Investment Company	37	82	119
2	Universal Basic Education Commission	132	236	368
TOTAL		169	318	487

Source: Field study (2024)

Sampling Frame

Sampling frame is defined as the list of members of the population from which the sample is selected (DiGaetano, 2013). The sampling frame for the study is comprised of construction and non-construction professionals who happened to be occupiers of offices within the study area. It is from the sample frame that the characteristics of the respondents were obtained and samples were drawn accordingly.

Sample Size

Sample size is the number of observations or replicates to include in a statistical sample (Simarjeet, 2017). The study requires respondents who are occupants/ users of offices within the study structures, believing that as occupants of such offices, they would have firsthand information on the level of comfort/ discomfort or satisfaction/ dissatisfaction derived from the features of their offices.

Considering the total population size of 487, the formula table proposed by Krejcie and Morgan (1970), formula table was adopted to determine the appropriate sample size suitable for population size of 401-500. Consequently, the formula presented 152 as the sample size befitting the population size. A total of 165 questionnaires were distributed, bearing in mind that not all the administered questionnaires will be returned or valid.

Sampling Technique

Sampling technique can be classified into five namely; simple random sampling, systematic random sampling, stratified random sampling, clustering random sampling and multi-stage sampling (Morenikeji, 2006). In view of the fact that this study only requires respondents who are occupants/ users of public building offices, giving preference to construction professionals who are believed to have better insight on the concept of GBT, the purposive sampling technique was adopted. The criteria for the selection being position in office, years of experience.

Method of Data Collection

Data collection for this study was carried out thoroughly because it has been adjudged by researchers as the heart of a research (Morenikeji, 2006). Therefore, issues of data collection method based on the source(s), instruments and procedure are discussed in this section.

Sources of data collection

Data collection for this study focused mainly on the primary source. However, the variables that formed the data to be collected from the field were obtained from review of literature of published materials which is more or less a secondary source of collecting information. Thereafter, issues on these data with respect to the study's objectives were sought directly from the respondents. This makes the source of data a primary source in the long run.

Instruments for data collection

The use of structured questionnaire was employed to collect data from professionals based on a five-point Likert scale format. The questionnaire was made up of five (5) SECTIONS (A - E) apart from the covering letter which is attached as a cover for the questionnaire. The first section (SECTION A) of the questionnaire collected data relating to the profile of the professionals considered for the study. The second section (SECTION B) of the questionnaire addressed issues relating to the first objective on the techniques involved in the adoption of GBT in the planning, design, construction and management of public office buildings in Abuja.

Procedure for data collection

Data collection for the study was undertaken in two phases. The first phase was carried out to gain insight on the respondents' location and population size. The second phase was the main survey which was undertaken to collect data on the aim and objectives of the study.

Method of Data Analysis

Before the commencement of data analysis, a reliability test was carried out to validate the research instruments. Pallant (2013) reported that the Cronbach's alpha coefficients of values above 0.700 suggests very good internal consistency reliability for the scale. This is considered acceptable for data to be reliable. Thereafter, 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 Spearman Rank correlation analysis. Frequency counts and percentage were used to analyse the profile of respondents while MIS and Spearman Rank correlation analysis were used to analyse data regarding the research objectives.

For the analysis of data, MIS was used to rank the opinion of respondents on the identified level of adoption of and satisfaction with the techniques involved in the adoption of GBT

in the planning, design, construction and management of public office buildings in Abuja based on opinions of respondents to achieve the first objective of the study.
MIS is being ranked from 1.00 to 5.00 and the decision rule adopted for the MIS analysis are summarized in Table 2. The formula used for calculating MIS for data analysis is expressed in Equations 3.1. 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 then there is large amount of correlation between the variables, as opined by Pallant (2013).

$$MIS = \frac{\Sigma W}{N} \text{---------- (3.1)}$$

Where: Σ = Summation, W = Weight, and N = Total

Table 2: Decision Rule for MIS Analysis

Scale	MIS Cut-off Point	Interpretation *Level of Adoption*	*Level of Satisfaction*	*Level of Severity*	*Level of Effectiveness*	*Level of Significance*
5	4.01 - 5.00	Highly Adopted	Highly Satisfied	Extremely Severe	Extremely Effective	Extremely Significant
4	3.01 - 4.00	Adopted	Satisfied	Very Severe	Very Effective	Very Significant
3	2.01 - 3.00	Moderately Adopted	Moderately Satisfied	Severe	Effective	Significant
2	1.01 - 2.00	Less Adopted	Dissatisfied	Less Severe	Less Effective	Less Significant
1	0.01 - 1.00	Not Adopted	Highly Dissatisfied	Least Severe	Least Effective	Least Significant

Source: Adapted and Modified from Shittu *et al.* (2022)

RESULTS AND DISCUSSION Results of Reliability Test

The questionnaire used for data collection was designed on a five-point Likert's Scale format in order to sample opinion of respondents. A reliability test was undertaken to validate the research questionnaire. It was observed that the Cronbach's alpha coefficient was 0.530 which was less than 0.70 recommended by Pallant (2013). Cronbach alpha values are, however, quite sensitive to the number of items in the scale. With short scales (e.g., scales with fewer than ten items), it is common to find quite low Cronbach values (e.g., 0.5).. In this case, it may be more appropriate to report the mean inter-item correlation for the items. Pallant (2013) recommended an optimal range for the inter-item

correlation of 0.2 to 0.4. In view of this, the mean inter-item correlation for the items in this study ranged from 0.1 – 0.5 which falls within the threshold of 0.2 – 0.4 as suggested by Pallant (2013). Therefore, the research questionnaire as well as the data it is measuring are reliable. The results of the reliability test are presented in Table 3.

Table 3: Results of Reliability Test

Code	Variable Name	A	B	C	D	E
		Inter-Item Correlation Matrix				
A	Adoption of Techniques Involved in the Adoption of GBT for Public Office Buildings	1.000	0.231	-0.037	0.174	-0.123
B	Satisfaction with GBT for Public Office Buildings	0.231	1.000	0.152	0.576	0.107
C	Effects of Adoption of GBT on Performance of Workers in Public Office Buildings	-0.123	0.107	0.098	-0.054	1.000
	Cronbach's Alpha			***0.530***		

Source: Field study, 2024

Analysis of Respondents' Profile

The profile of the respondents that were considered for the field work of this study is presented in this section, as shown in Table 4. In view of this, the results in Table 4 shows that of the total number of 105 copies of questionnaires distributed, 77 were returned, correctly filled and used for analysis. This gives a response rate of 73%. The profile of the respondents presented in Table 4 also indicates that the majority of the respondents were Engineers, representing 27% of the total number of respondents. This is followed by the respondents who are Estate Valuers and Town Planners, representing 18% of the population respectively. The remaining respondents are Quantity Surveyors, representing 16%; Architects, representing 14%; and Builders, representing 6%. It is also revealed that 90% of the respondents are registered members of their professional associations. These imply that the respondents were made up of a good mix of the relevant professionals that can provide reliable information required for this study.

It can also be noted from the results presented in Table 4 that majority of the respondents are holders of Bachelor's degree, representing 38% of the total population respectively. This is followed by respondents who are holders of Higher National Diploma, representing 29% of the total population. The other respondents are holders of Master's Degree (representing 23% of the population) and National Diploma (representing 10% of the population). This indicates that the respondents are educated enough to provide reliable information needed for this study. The profile presented in Table 4 also reveals that

majority of the respondents (38%) have 11-15 years' experience, while 30% of the respondents have 16-20 years' experience. The other respondents have Above 20 (14% of the population), 6-10 years' experience (13% of the population) and 11-15 years' experience (5% of the population). This shows that the respondents have enough experience to provide reliable information required for this study. Finally, the profile of respondents presented in Table 4 indicates that majority of the respondents (75% of the population) have been involved in the construction projects where the use of Green Building Technology (GBT) was adopted, while only 25% of the respondents have not been involved in the construction projects where the use of GBT was adopted. This shows that the respondents are in a good position to offer reliable data required for this study.

Table 4: Respondents' Profile

PROFILE		FREQUENCY	PERCENTAGE (%)
Questionnaire Distribution	No. of Questionnaire Distributed	105	
	No. of Questionnaire Returned	77	
	Response Rate	***73***	
Respondents' Profession	Architect	11	14
	Builder	5	6
	Engineer	21	27
	Estate Valuer	14	18
	Quantity Surveyor	12	16
	Town Planner	14	18
	Total	***77***	***100***
Respondents' Professional Qualification	MNIA/ARCON	11	14
	MNIOB/CORBON	4	5
	MNSE/COREN	19	25
	NIESV/ESVABON	11	14
	MNIQS/QSRBN	10	13
	MNITP/TOPREC	14	18
	Total	***69***	***90***
Respondents' Highest Academic Qualification	National Diploma (ND)	8	10
	Higher National Diploma (HND)	22	29
	Bachelor's Degree (BSc/BTech)	29	38
	Master's Degree (MSc/MTech)	18	23
	Total	***77***	***100***
	1-5 Years	4	5

Respondents' Years of Experience	6-10 Years	10	13
	11-15 Years	29	38
	16-20 Years	23	30
	Above 20 Years	11	14
	Total	***77***	***100***
Involvement in the construction projects where the use of Green Building Technology (GBT) was adopted	YES	58	75
	NO	19	25
	Total	***77***	***100***

Source: Field study, 2024

Adoption of Techniques Involved in GBT for Public Office Buildings

This section ranked the perception of respondents on the level of adoption of techniques involved in the adoption of GBT for public office buildings and the level of satisfaction with GBT for Public Office Buildings in Abuja.

Level of adoption of techniques involved in the adoption of GBT

This study identified twenty-three (23) techniques involved in the adoption of GBT for public office buildings. The results of the MIS ranking of the perception of respondents on the level of adoption these techniques are presented in Table 5. Therefore, the results presented in Table 5 indicate that the techniques involved in the adoption of GBT for public office buildings most adopted were "Daylighting" (MIS = 4.18); "Direct solar gain" (MIS = 4.04) and "Indirect solar gain" (MIS = 3.94). The least adopted techniques involved in the adoption of GBT for public office buildings were "Acoustics" (MIS = 2.86); "Surveys and sensors" (MIS = 2.86) and "Glare" (MIS = 2.74). In addition, the techniques involved in the adoption of GBT for public office buildings which were highly adopted range were "Daylighting" (MIS = 4.18) and "Daylighting" (MIS = 4.04). The techniques involved in the adoption of GBT for public office buildings which were averagely adopted range from "Indirect solar gain" (MIS = 3.94) to "Mechanical systems" (MIS = 3.18). The techniques involved in the adoption of GBT for public office buildings which were moderately adopted range from "Indoor pollutant source control" (MIS = 2.92) to "Glare" (MIS = 2.74). On the average, all the identified techniques involved in the adoption of GBT for public office buildings in Abuja were averagely adopted (average MIS = 3.41).

Level of satisfaction with GBT for public office buildings

The techniques involved in the adoption of GBT for public office buildings were classified into four (4) from the review of extant literature in this study. These are Indoor Air Quality, Thermal Comfort (Temperature and Humidity), Lighting and Acoustics. The results of the MIS ranking used to rate respondents' opinions on the level of satisfaction

with GBT for public office buildings based on each of these four groups of parameters are highlighted in Table 5. In view of this, on the issue of Indoor Air Quality, the technique involved in the adoption of GBT which was most satisfied with was "Minimum Indoor Air Quality Performance" (MIS = 3.75), while the technique involved in the adoption of GBT which was least satisfied with was "Low-Emitting Materials" (MIS = 3.05). On the average, the occupants were averagely satisfied with all the six techniques involved in the adoption of GBT in terms of Indoor Air Quality (average MIS = 3.48). In terms of Thermal Comfort, the occupants were averagely satisfied with the Thermal Comfort in the office buildings (MIS = 3.27).

With respect to Lighting, the technique involved in the adoption of GBT which was most satisfied with was "Daylight" (MIS = 3.48), while the technique involved in the adoption of GBT which was least satisfied with was "Interior Lighting" (MIS = 3.30). On the average, the occupants were averagely satisfied with all the four techniques involved in the adoption of GBT in terms of Lighting (average MIS = 3.38). In terms of Acoustics, the occupants were averagely satisfied with the two techniques under acoustics which are "Acoustic comfort and noise" (MIS = 3.14) and "Acoustic performance" (MIS = 3.12). On the average, the occupants were averagely satisfied with all the two techniques involved in the adoption of GBT in terms of Acoustics (average MIS = 3.13).

Table 5: Level of Satisfaction with GBT for Public Office Buildings

Code	Level of Satisfaction with GBT for Public Office Buildings	MIS	Rank	Decision
Code	***Indoor Air Quality***	***MIS***	***Rank***	***Decision***
S1	Minimum Indoor Air Quality Performance	3.75	1st	Averagely Satisfied
S2	Enhanced Indoor Air Quality Strategies	3.74	2nd	Averagely Satisfied
S3	Indoor Air Quality Assessment	3.66	3rd	Averagely Satisfied
S4	Construction IAQ Management Plan	3.49	4th	Averagely Satisfied
S5	Environmental Tobacco Smoke Control	3.21	5th	Averagely Satisfied
S6	Low-Emitting Materials	3.05	6th	Averagely Satisfied
S7	***Average MIS***	***3.48***		***Averagely Satisfied***
Code	***Thermal Comfort (Temperature and Humidity)***	***MIS***	***Rank***	***Decision***
S8	Thermal Comfort	3.27		Averagely Satisfied
Code	***Lighting***	***MIS***	***Rank***	***Decision***
S9	Daylight	3.48	1st	Averagely Satisfied

Respondents' Years of Experience	6-10 Years	10	13
	11-15 Years	29	38
	16-20 Years	23	30
	Above 20 Years	11	14
	Total	***77***	***100***
Involvement in the construction projects where the use of Green Building Technology (GBT) was adopted	YES	58	75
	NO	19	25
	Total	***77***	***100***

Source: Field study, 2024

Adoption of Techniques Involved in GBT for Public Office Buildings

This section ranked the perception of respondents on the level of adoption of techniques involved in the adoption of GBT for public office buildings and the level of satisfaction with GBT for Public Office Buildings in Abuja.

Level of adoption of techniques involved in the adoption of GBT

This study identified twenty-three (23) techniques involved in the adoption of GBT for public office buildings. The results of the MIS ranking of the perception of respondents on the level of adoption these techniques are presented in Table 5. Therefore, the results presented in Table 5 indicate that the techniques involved in the adoption of GBT for public office buildings most adopted were "Daylighting" (MIS = 4.18); "Direct solar gain" (MIS = 4.04) and "Indirect solar gain" (MIS = 3.94). The least adopted techniques involved in the adoption of GBT for public office buildings were "Acoustics" (MIS = 2.86); "Surveys and sensors" (MIS = 2.86) and "Glare" (MIS = 2.74). In addition, the techniques involved in the adoption of GBT for public office buildings which were highly adopted range were "Daylighting" (MIS = 4.18) and "Daylighting" (MIS = 4.04). The techniques involved in the adoption of GBT for public office buildings which were averagely adopted range from "Indirect solar gain" (MIS = 3.94) to "Mechanical systems" (MIS = 3.18). The techniques involved in the adoption of GBT for public office buildings which were moderately adopted range from "Indoor pollutant source control" (MIS = 2.92) to "Glare" (MIS = 2.74). On the average, all the identified techniques involved in the adoption of GBT for public office buildings in Abuja were averagely adopted (average MIS = 3.41).

Level of satisfaction with GBT for public office buildings

The techniques involved in the adoption of GBT for public office buildings were classified into four (4) from the review of extant literature in this study. These are Indoor Air Quality, Thermal Comfort (Temperature and Humidity), Lighting and Acoustics. The results of the MIS ranking used to rate respondents' opinions on the level of satisfaction

with GBT for public office buildings based on each of these four groups of parameters are highlighted in Table 5. In view of this, on the issue of Indoor Air Quality, the technique involved in the adoption of GBT which was most satisfied with was "Minimum Indoor Air Quality Performance" (MIS = 3.75), while the technique involved in the adoption of GBT which was least satisfied with was "Low-Emitting Materials" (MIS = 3.05). On the average, the occupants were averagely satisfied with all the six techniques involved in the adoption of GBT in terms of Indoor Air Quality (average MIS = 3.48). In terms of Thermal Comfort, the occupants were averagely satisfied with the Thermal Comfort in the office buildings (MIS = 3.27).

With respect to Lighting, the technique involved in the adoption of GBT which was most satisfied with was "Daylight" (MIS = 3.48), while the technique involved in the adoption of GBT which was least satisfied with was "Interior Lighting" (MIS = 3.30). On the average, the occupants were averagely satisfied with all the four techniques involved in the adoption of GBT in terms of Lighting (average MIS = 3.38). In terms of Acoustics, the occupants were averagely satisfied with the two techniques under acoustics which are "Acoustic comfort and noise" (MIS = 3.14) and "Acoustic performance" (MIS = 3.12). On the average, the occupants were averagely satisfied with all the two techniques involved in the adoption of GBT in terms of Acoustics (average MIS = 3.13).

Table 5: Level of Satisfaction with GBT for Public Office Buildings

Code	Level of Satisfaction with GBT for Public Office Buildings	MIS	Rank	Decision
Code	***Indoor Air Quality***	***MIS***	***Rank***	***Decision***
S1	Minimum Indoor Air Quality Performance	3.75	1st	Averagely Satisfied
S2	Enhanced Indoor Air Quality Strategies	3.74	2nd	Averagely Satisfied
S3	Indoor Air Quality Assessment	3.66	3rd	Averagely Satisfied
S4	Construction IAQ Management Plan	3.49	4th	Averagely Satisfied
S5	Environmental Tobacco Smoke Control	3.21	5th	Averagely Satisfied
S6	Low-Emitting Materials	3.05	6th	Averagely Satisfied
S7	***Average MIS***	***3.48***		***Averagely Satisfied***
Code	***Thermal Comfort (Temperature and Humidity)***	***MIS***	***Rank***	***Decision***
S8	Thermal Comfort	3.27		Averagely Satisfied
Code	***Lighting***	***MIS***	***Rank***	***Decision***
S9	Daylight	3.48	1st	Averagely Satisfied

S10	lighting and daylight	3.42	2nd	Averagely Satisfied
S11	Quality View	3.32	3rd	Averagely Satisfied
S12	Interior Lighting	3.30	4th	Averagely Satisfied
	Average MIS	***3.38***		***Averagely Satisfied***
Code	***Acoustics***	***MIS***	***Rank***	***Decision***
S13	Acoustic comfort and noise	3.14	1st	Averagely Satisfied
S14	Acoustic Performance	3.12	2nd	Averagely Satisfied
	Average MIS	***3.13***		***Averagely Satisfied***

Source: Field study, 2024

Perceived effects of adoption of GBT on performance of workers in public office buildings

The results of the MIS ranking of the perception of respondents on the perceived effects of adoption of GBT on performance of workers in public office buildings are presented in Table 6. based on this, the results presented in Table 6 reveal that the most significant effects of adoption of GBT on performance of workers in public office buildings were "GBT results in a high-quality" (MIS = 4.03); "GBs help to reduce the demand for new power plants" (MIS = 3.91); and "Reduced cost for alterations" (MIS = 3.86). The least significant effects of adoption of GBT on performance of workers in public office buildings were "By applying its purposed concept, GBs can save operational costs/ Optimized asset management and better space utilization" (MIS = 3.17); "GB provides healthy environment throughout the lifetime of its construction" (MIS = 3.08); and "GBT serves as a means of reducing of green-house gas emissions and improving the chances of human sustainability" (MIS = 3.05). On the average, all the perceived effects of adoption of GBT on performance of workers in public office buildings in Abuja were very significant (average MIS = 3.45).

Table 6: Perceived Effects of Adoption of GBT on performance of Workers in Public Office Buildings

Code	Perceived Effects Adoption of GBT on performance of Workers in Public Office Buildings	MIS	Rank	Decision
1	GBT results in a high-quality	4.03	1st	Extremely Significant
2	GBs help to reduce the demand for new power plants	3.91	2nd	Very Significant
3	Reduced cost for alterations	3.86	3rd	Very Significant
4	Leverage renewable energy technologies	3.68	4th	Very Significant

5	GB approach can influence the property value of office buildings through the relation of its utility and scarcity	3.65	5th	Very Significant
6	Advances the health of local and regional ecosystems	3.62	6th	Very Significant
7	GB provides for occupant comfort	3.58	7th	Very Significant
8	Advance capabilities to deal with "Chun" (occupant turnover/evolving mission); Reduced future capital expenditures; and Higher resale value or lease rates	3.57	8th	Very Significant
9	Reduced energy and water usage	3.55	9th	Very Significant
10	Conducive and efficient buildings help in increasing productivity by reducing absenteeism through healthy environment	3.49	10th	Very Significant
11	Reduced construction and demolition waste	3.49	10th	Very Significant
12	Reduced future capital expenditures	3.44	12th	Very Significant
13	Protects the environment by conserving energy, water, materials and other resources	3.42	13th	Very Significant
14	Higher resale value or lease rates	3.42	13th	Very Significant
15	The GBT involves the practice whereby energy is utilized in a way that it would not jeopardise continuity of energy usage in the environment	3.40	15th	Very Significant
16	Enhances residents' connection to nature	3.38	16th	Very Significant
17	Reduction of life-cycle building and running costs	3.38	16th	Very Significant
18	GBT slows down the pace of global climate change	3.38	16th	Very Significant
19	GBT improves a healthy living environment	3.36	19th	Very Significant
20	Proper harnessing of the natural resources (sunlight, ventilation)	3.36	19th	Very Significant
21	GBT results in enhanced Indoor Environmental Quality (IEQ)	3.35	21st	Very Significant
22	GB helps in the reduction of operating costs, such as energy and water as a result of the green features and facilities that are integrated into it	3.35	21st	Very Significant
23	Lowers residents' utility costs	3.32	23rd	Very Significant
24	Advance capabilities to deal with "Chun" (occupant turnover/evolving mission)	3.25	24th	Very Significant

25	Enhanced IEQ from GBT results in improved individual productivity of office building occupants	3.23	25th	Very Significant
26	By applying its purposed concept, GBs can save operational costs	3.17	26th	Very Significant
27	Optimized asset management and better space utilization	3.17	26th	Very Significant
28	GB provides healthy environment throughout the lifetime of its construction	3.08	28th	Very Significant
29	GBT serves as a means of reducing of green-house gas emissions and improving the chances of human sustainability	3.05	29th	Very Significant
	Average MIS	***3.45***		***Very Significant***

Source: Field study, 2024

Table 7 reveals the relationship between adoption of GBTs and performance of workers in public office buildings with regards to Indoor Air Quality, Thermal Comfort (Temperature and Humidity), Lighting and Acoustics using the Spearman Rank correlation analysis.

Table 7: Relationship between Adoption of GBTs and Performance of Workers in Public Office Buildings

ANALYSIS NO.	VARIABLES		OBSERVATIONS		INFERENCES		
	X_1	X_2	*r* (%)	LOS	P_{value}	Strength of Relationship	Remark
1	GBTs	Indoor Air Quality	0.474	0.01	0.000	Strong	SS
2	GBTs	Thermal Comfort	0.124	0.01	0.283	Weak	NS
3	GBTs	Lighting	0.420	0.01	0.000	Strong	SS
4	GBTs	Acoustics	0.057	0.01	0.624	Weak	NS

Source: Field study, 2024

KEY:

SS = Statistically Significant
NS = Not Significant
r = Correlation Coefficient

LOS = Study's Level of Significance
P_{value} = Calculated Probability Value
GBTs = Greem Building Techniques

Discussion of Findings

This study identified twenty-three (23) techniques involved in the adoption of GBT for public office buildings. The results presented in Section 4.3.1 of the questionnaire revealed that on the average, all the identified techniques involved in the adoption of GBT for public office buildings in Abuja were averagely adopted (average MIS = 3.41). In addition, it was revealed in Section 4.3.2 that occupants are averagely satisfied with GBT for public office buildings in terms of Indoor Air Quality (average MIS = 3.48), Thermal Comfort (MIS = 3.27), Lighting (average MIS = 3.38) and Acoustics (average MIS = 3.13). In line with the findings of this study, past studies have reported that in Nigeria, over the years due to increased awareness, GB materials are being systematically introduced into new buildings during Retrofit and Renovation works, e.g., use of wooden floors, Recycling household waste water, Use and Installation of Solar Powered Devices and Panels for household electricity (Anzagira *et al.*, 2021). On the other hand, Babarinde *et al.* (2019) submitted that it is also a major setback to note that Nigeria has not developed its own home-grown GB Rating.

The study found that on the average, all the perceived effects of adoption of GBT on performance of workers in public office buildings in Abuja were very significant (average MIS = 3.45). It was also revealed that there exists a strong, positive and significant relationship between the adoption of Indoor Air Quality/Lighting and workers' satisfaction in public office buildings in Abuja (r = 0.474/0.420; p = 0.000). On the other hand, there exists a weak, positive and non-significant relationship between the adoption of Thermal Comfort/Acoustics and workers' satisfaction in public office buildings in Abuja (r = 0.124/0.057; p = 0.283/0.624). Past studies also agree with the findings of this study here. For instance, it was reported that adoption of GBT creates transformative impact on employee happiness and engagement at work. This is because advocates of GBs have stated that enhanced GBT adoption results in improved individual performance of office building occupants (Alker *et al.*, 2014).

Summary of Findings

From the results of the analysis of data undertaken, it shows that:

> The techniques involved in the adoption of GBT for public office buildings most adopted were "Daylighting" (MIS = 4.18); "Direct solar gain" (MIS = 4.04) and "Indirect solar gain" (MIS = 3.94). On the average, all the identified techniques involved in the adoption of GBT for public office buildings in Abuja were averagely adopted (average MIS = 3.41). Occupants are averagely satisfied with GBT for public office buildings in terms of Indoor Air Quality (average MIS = 3.48), Thermal Comfort (MIS = 3.27), Lighting (average MIS = 3.38) and Acoustics (average MIS = 3.13).

CONCLUSION AND RECOMMENDATIONS

Conclusion

Regardless of the growing adoption of green building technology (GBT) in public office buildings in Abuja, Nigeria, there is a lack of understanding of how these technologies

affect workers' performance, health, and overall well-being. The study found that the techniques involved in the adoption of GBT for public office buildings most adopted are "Daylighting"; "Direct solar gain" and "Indirect solar gain" and all the identified techniques involved in the adoption of GBT for public office buildings in Abuja are averagely adopted. In addition, occupants are averagely satisfied with GBT for public office buildings in Abuja especially with respect to Indoor Air Quality, Thermal Comfort, Lighting and Acoustics.

Moreso, it was established that the relationship between the adoption of Indoor Air Quality/Lighting and workers' satisfaction in public office buildings in Abuja is strong, positive and significant. On the other hand, the relationship between the adoption of Thermal Comfort/Acoustics and workers' satisfaction in public office buildings in Abuja was found to be weak, positive and non-significant. The study therefore concludes that the impact of GBT on workers' performance in public office buildings in Abuja is significant and can enhance healthier working environment and maximum performance for office workers.

Recommendations

i. Construction firms should focus more attention on the maximum utilisation of "Daylighting", "Direct solar gain", "Indirect solar gain", Indoor Air Quality, Thermal Comfort, Lighting and Acoustics in order to improve the level of satisfaction of workers with GBT for public office buildings for improved workers' performance.

ii. It is also imperative for construction firms to collaborate with other stakeholders to set up mechanism for enhancing the adoption of GBT for public office buildings in Abuja. This can be achieved by exploring the relationship between GBT adoption and performance of workers in public office buildings focusing more attention on the strategies for enhancing the relationship between adoption of Thermal Comfort/Acoustics and workers' satisfaction.

Contribution to Knowledge

The following are the contributions of this study to the body of knowledge:

i. The study sought to identify the technologies and techniques involved in the adoption of GBT in the planning, design, construction and management of public office buildings in Abuja. The study identified twenty-three (23) techniques involved in the adoption of GBT for public office buildings of which the most adopted are "Daylighting" (MIS = 4.18); "Direct solar gain" (MIS = 4.04) and "Indirect solar gain" (MIS = 3.94).

ii. The study also targeted at ascertaining the effect of the adoption of GBT on the performance of workers in public office buildings. The study established that all the twenty-nine (29) perceived effects of the adoption of GBT on the performance of workers in public office buildings in Abuja are very significant (average MIS = 3.45) with the most significant effects being "GBT results in a high-quality" (MIS = 4.03); "GBs help to reduce the demand for new power plants" (MIS = 3.91); and "Reduced cost for alterations" (MIS = 3.86). In addition, it was established that the relationship between the adoption of Indoor Air Quality/Lighting and workers' satisfaction in public office buildings in Abuja is strong, positive and significant (r = 0.474/0.420; p = 0.000).

Areas for Further Studies

In view of the limitations of financial and time constraints faced by this study, the following areas are suggested for further research:

i. Impact of Green Building Technology on workers' safety performance in public office buildings in Abuja.
ii. buildings.

REFERENCES

Alker, J., Malanca, M., Pottage, C. & O'Brien, R. (2014). Health, Wellbeing & Productivity in Offices. The next chapter for green building. *World Green Building Council.*

Asakawa, M. (2021). A Just and Affordable Transition toward Net Zero – Speech. *2021 International Climate Change Conference.* 22 July 2021. https://www.adb.org/news/speeches/2021-international-climate-change-conference-just-affordable-transition-net-zero-masatsugu-asakawa

Daniel, A. A. & Odoala, M. (2018). The Usage of Green in Office Buildings: An Appraisal of Some Office Spaces in University of Jos.

Gregory, K. (2006). Greening America's schools costs and benefits. The U.S. Green Building Council. Downloaded on May 20, 2024 from http://www.usgbc.org/Docs/Archive/General/Docs2908.pdf

Havard Business Review (2018). The Benefits of Green Building.

Kats, G. (2018). Greening Our Built World. Harvard Business Review.

KeTTHA (2011). Definisi Teknologi Hijau. Downloaded on 31 May 2024 at: http://www.kettha.gov.my/content/definisi

Li Xu, Bin Zhou and Chuxin Wang (2015)., researched on Design Technology of GB for Environmental. Environmental Art Institute, *Environmental Management College of China*, Qinhuangdao, China.

Mansinghka, A. & Mohan, N. (2021). The Effects of Low Productivity on Business Growth. Retrieved 02 05, 2024, from https://www.saviom.com/blog/effects-of-low-productivity-business-growth/

Mishra, P. (2020). The Importance of Green Buildings in Contemporary India. Retrieved 02- 05, 2021, from http://bwsmartcities.businessworld.in/article/The-Importance-of-Green-Buildings-in-Contemporary-India/03-07-2020-293584/

Morenikeji, W. (2006). Research and Analytical methods (for social scientist, planners and environmentalist). Jos University Press Limited, Jos. 102, 180-182.

Pallant, J. (2013). *SPSS Survival Manual: A Step-by-Step Guide to Data Analysis Using SPSS (5th Edition).* Australia: Allen & Uwin Publishers

Samari, M., Godrati, N., Esmaeilifar, R., Oifat, P. & Shafei, M. W. (2013). The Investigation of the Barriers in Developing Green Building in Malaysia. *Modern Applied Science,* 7(2), 75-87. Canadian center of Science and Education. ISSN: 1913-1844

Shittu, A. A., Popoola, K., Tsado, A. J., Shehu, M. A. & Abdulazeez, S. R. (2022). Impact of Safety Measures for Hazard Recognition on the Rate of Accidents on Construction Sites in Abuja, Nigeria. *Journal of Building Performance.* Universiti Kebangsaan Malaysia and The Royal Institution of Surveyors, Malaysia. 13(1), 26 – 34. ISSN: 2180-2106. Available online at: http://spaj.ukm.my/jsb/index.php/jbp/index

Singh, A., et al. (2019). Impact of Green Buildings on Worker Productivity. Journal of Building Engineering.

University of Califonia, Berkeley/ (2019), The Impact of Green Building on Worker Productivity.

Vischer J.C & Preiser W.F (2005). Assessing Building Performance. Published by *Butterworth- Heinemann*, an imprint of Elsevier page 3.

Yousef, A. H., Mohammed, A., Kaushik, A., Mazroei, A., Katafygiotou, M. & Elsarrag, E. (2016). Occupant productivity and office indoor environment quality: A review of the literature. *Building and Environment,* 1323(16).