VOL. 02 NO. 2,
DECEMBER, 2023
E-ISSN 3026-9210
P-ISSN 3026-815X



African Scholar Publications & Research International
www.africanscholarpub.com

Journal of Built Env. & Geological Research (JBEGR)

Integrating Green Architecture Principles in the Design of Office Building towards Improved Energy Consumption in Abuja, Nigeria

Idowu, D.F.; and Abdulrahman, M.E
Department of Architecture, Federal University of Technology, Minna, Nigeria.

Abstract

The growing concerns over the adverse effects of buildings on the environment and the need to achieve users' thermal, visual, acoustic, spatial, and indoor environmental air quality comfort have given rise to the demand for energy-efficient buildings. This study aims to integrate green architecture principles into the design of an office building in Abuja, Nigeria, with the goal of improving artificial energy consumption for optimal building performance. The research instrument that was employed for data collection was the survey questionnaire administered to professionals in the built industry and occupants of office buildings. Four hundred and sixty five (465) questionnaires were administered to the study population, and three hundred fifty (350) questionnaires (75%) retrieved. The analysis of the data was carried out using descriptive analysis, percentage, and mean item score. The findings revealed that respondents agreed that the energy use and activities in office buildings in Abuja led to an increase in the amount spent on fuel (MIS = 4.32). The findings further revealed that the respondents agreed that green architecture policies should be enforced in Nigeria (MIS = 4.40). The findings revealed that the office environment in relation to the following: natural lighting and natural ventilation (MIS = 3.44 and 3.31) are good. The study concluded that integrating green architecture principles is necessary for improving energy consumption in the design of office buildings. It was recommended that designers should ensure the implementation of proper design and orientation, leveraging climatic conditions and the use of more efficient equipment, which helps reduce energy consumption, consequently leading to a reduction in energy bills, improved indoor air quality, and lower carbon emissions.

Keywords: Green Architecture Principles, Energy Efficiency and Office Buildings

Introduction

Davenport (2018) asserts that, office buildings consume a significant amount of energy during both construction and occupation. This high energy consumption has negative consequences on both the environment and the health and comfort of building occupants. Green building is the use of approaches that create buildings and development that are environmentally responsible and resource-efficient throughout a building's life cycle, from site selection to demolition or reuse. David and Olabode (2015) emphasises that, the concept of green building is becoming increasingly popular in the developed world as a standard to reduce the environmental impact of both existing building and new constructions. Kats (2003) defines green or sustainable buildings as those that use key resources like energy, water, materials, and land more efficiently than buildings that are just built to code. Green buildings typically contribute to improved productivity, health, and comfort of people and the environment by providing more natural light and better air quality. Green buildings incorporate measures that are environmentally friendly and resource-efficient across the building lifecycle, aiming to comprehensively minimize the negative impact and maximize the positive impact a building has on its natural environment and human occupants.

According to Idris and Dawi (2019), Nigeria, the biggest economy in Africa, faces a significant challenge in power generation, with no investment in the power sector between the mid-1980s and the end of the 1990s. Energy supply is crucial for sustainable real sector operations, and there is a considerable gap between the energy generated for on-grid supply and the end-user consumed energy. The weak/old transmission and distribution facilities are responsible for this gap

The study further presents a detailed review of possible solutions to energy consumption in buildings through integrated smart façade green retrofitting. It focuses on the use of smart façade technology to retrofit existing office buildings in Abuja, Nigeria, and highlights the potential benefits of smart façade technology, which includes the reduction of energy consumption, improved indoor air quality, and increased thermal comfort for building occupants. The authors also discuss the challenges associated with the implementation of smart façade technology, such as high initial costs and the need for specialized expertise. The energy situation in Nigeria is

characterized by a high and increasing demand, inadequate, insecure, and irregular supply, and a fossil fuel-dominated energy mix that is environmentally unfriendly and fast depleting. To address these challenges, Nigeria needs to diversify its energy supply mix by installing appropriate infrastructure and creating awareness to promote and develop the abundant renewable energy resources available in the country.

LITERATURE REVIEW

Green Architecture Design Features

Erebor *et al.* (2022) identified 29 energy efficiency design features that can be integrated into office buildings in Abuja, Nigeria. These features include colours as design features, window size, wall cladding, heat sink, Trombe walls, autoclaved aerated concrete walls, double skin facades, ventilated or double skin walls, climate adaptive shells, kinetic facades, energy-efficient ceilings, LED lighting, low emissivity window glazing, energy recovery vent systems, HVAC systems, high-efficiency solar water heater, energy-efficient landscaping elements, layer of insulation, structural insulated panel, insulated block wall, wide overhangs, sun shading device, smart windows, smart doors, solar panels, windmills, green roofs, vents in the roof, and atria as a design feature. Furthermore, stating several techniques for achieving energy efficiency in buildings, such as proper building orientation, window-to-wall ratio, use of inverter air conditioning, and local climate roofing and other building materials.

The study by Xu *et al.* (2023) examines the differences in building energy consumption distribution characteristics among different office blocks, the effect of block morphological parameters on building energy consumption, and the key morphological parameters that have a combined effect on building energy consumption in office blocks. The study concludes that block morphology has a significant effect on building energy consumption, and the compactness of the block is the most important factor affecting energy consumption. Furthermore, Khalifa *et al.* (2023) conducted a study to investigate the impact of using smart windows in reducing energy consumption and improving building performance in an office building. It revealed that, the use of smart windows can significantly reduce energy consumption in buildings. Smart windows are designed to regulate the amount of light and heats entering a building, which can help reduce energy consumption thereby enhancing the overall performance of a building. Additionally, due consideration should be given the dimensions, orientation, and placement of window elements within the building facade.

Majid *et al.* (2023) examines green attribute preferences in residential buildings in Kano, Nigeria. The study found that the most preferred green attributes in residential buildings in Kano include energy-efficient lighting, water-efficient fixtures, and the

use of renewable energy sources. While the study focuses on residential buildings, the findings can be applied to office buildings as well. Green architecture principles such as energy-efficient lighting and the use of renewable energy sources can be incorporated into office buildings to make them more environmentally friendly and sustainable.

Erebor and Adedire (2023) opined that, architects should consider the factors that influence the adoption, integration, and use of low carbon emissivity strategies and features whilst also putting the following outlined strategies into consideration:

i. Building orientation: Buildings should be oriented to maximize natural light and ventilation while minimizing solar heat gain.
ii. Insulation: Adequate insulation should be provided to reduce heat loss and gain.
iii. Window design: Windows should be designed to maximize natural light while minimizing solar heat gain.
iv. Low-emissivity materials: Low-emissivity materials should be used to reduce heat transfer through thermal radiation. The main focus for low-e materials is to reduce the heat transfer through thermal radiation. Furthermore, low-e materials will also influence on the daylight.
v. Energy-efficient lighting: Energy-efficient lighting should be used to reduce energy consumption.
vi. Renewable energy: Renewable energy sources such as solar and wind should be considered to reduce reliance on fossil fuels.

Furthermore, Architects should also consider the life-cycle perspective of the building, including embodied energy use and operational processes, to reduce carbon emissions in order to provide the design of office buildings that are energy-efficient, environmentally friendly, and sustainable.

Green Building Certification

According to Adewolu (2023), green building certifications ensure that buildings are designed, constructed, and operated with minimal environmental impact. Obtaining a green building certification involves meeting specific criteria and requirements related to energy efficiency, water conservation, indoor air quality, materials used, and overall sustainability. These certifications help reduce energy consumption, greenhouse gas emissions, and operating costs while improving indoor environmental quality and property value. According to the United States Green Building Council, green buildings consume 25% less energy and can result in a 19% reduction in operating costs compared to traditional buildings.

Research has shown that green building grading systems can enhance a building's sustainability and reduce its environmental impact. The effectiveness of certain rating systems can be influenced by factors such as the area, specific demands, and challenges of the local environment (Bungau *et. al.,* 2022). In Nigeria, there has been a growing interest in certification for environmentally friendly buildings in recent years, and the use and effectiveness of grading systems like LEED, EDGE, and BREEAM are still being studied (Dabara, 2017). Green building rating systems exist for various project types, including single-family houses, commercial buildings, and entire neighbourhoods. These systems can be used for new construction, which focuses on decisions made in the planning and design process and actions taken during construction, as well as for existing buildings, which focus on operations and maintenance throughout the building's life. Green buildings, such as those certified by LEED, are a global solution for cities, communities, and neighbourhoods. They reduce carbon emissions, energy and waste, conserve water, prioritize safer materials, and lower exposure to toxins, contributing to the global growth of the industry (USGBC, 2023). LEED certification provides a framework for healthy, highly efficient, and cost-saving green buildings that offer environmental, social, and governance benefits. LEED-certified buildings are critical to addressing climate change, enhancing resilience, and supporting more equitable communities.

Advantages of Implementing Green Architectural Principles

Hor and Rahmat (2018) asserted that, incorporating green features in office buildings in both developed and developing economies can have a significant impact on the developmental strides and targets of low carbon emissivity set by their governments. This can lead to increased productivity of workers within the office spaces and the built environment at large. Additionally, greening the environment can lead to huge reductions in building costs in terms of energy provisions within them and also reducing running costs in the short and medium term. Musa and Abdullahi (2018) also believe that on a global scale, greening buildings can serve advantageous purposes since they have embodied energies that could drop down global building energy consumption by as much as 30 percent. They further state that construction professionals have the principal roles of enforcing greening within the design and construction industry since the principal focus is to achieve office building energy efficiency and sustainability because buildings have the tendency of polluting the environment. The construction industry has a significant impact on greenhouse-gas (GHG) emissions in the context of buildings. Incorporating green features in buildings can reduce energy consumption from heating, ventilation, and air conditioning, leading to a reduction in carbon emissions.

Challenges of Integrating Green Architecture Principles

Research has been conducted on the three key dimensions of green buildings (environmental, social, and economic) to determine their importance and acceptance levels (Said *et al.*, 2016, 2017, 2020). However, research gaps have been identified by Zuo & Zhao (2014) based on assessment tools' effectiveness, specific population demands, and future-proofing considerations. Consequently, understanding the demand for green buildings is crucial, as preferences depend on desired attributes and the population's willingness to adopt them. Furthermore, Erebor *et al.* (2022) found that building professionals in Abuja have a moderate level of knowledge of energy efficiency design features, with a mean score of 2.98 out of 5. The study also found that the integration level of energy efficiency design features in selected office buildings in Abuja is low, with a mean score of 2.22 out of 5. The study identified several factors that hinder the integration of energy efficiency design features in office buildings in Abuja, including a lack of awareness, inadequate training, and limited incentives. The study recommends that building professionals in Abuja should be adequately trained and educated on energy efficiency design features to improve their knowledge and integration levels. The study also recommends that the government should provide incentives to encourage the integration of energy efficiency design features in office buildings in Abuja.

The study by Jegede *et al.* (2021) evaluated the use of green facade as a sustainable element in constructing residential buildings in Kubwa, Abuja, Nigeria. The study used Kubwa district in FCT Abuja as the study area and primary data was derived by the administration of structured questionnaire to residents living in Kubwa. The data was analyzed using the descriptive statistical tools of frequency and percentages of the Statistical Package for Social Sciences (SPSS). Findings from the research indicated that there are social and physical factors that have hindered the use of green facade in the study area. The major factors responsible for this include difficulty in getting professional help and low financial status. The study recommended that both the government and the private sectors intensify efforts towards enforcing housing policies, creating incentives and delivering regular symposiums that will encourage green architectural practices such as the use of green facade in residential building and all its. However, the study did not focus on green architecture principles in office buildings.

METHODOLOGY

The research design employed in this research is descriptive survey via quantitive. The population for this study comprises of users of office buildings and professionals in the built industry. The total projected population for Abuja is 3,840,000. A simple random sampling methods were used to select the representative and respondents for

the study. The simple random sampling ensures that each member of the population has an equal chance for the selection or the chance of getting a response which can be more than equal to the chance depending on the data analysis justification. Krejcie and Morgan's formulas for determining the sample size provide identical sample sizes in cases where the researcher adjusts the tabulated value based on the size of the population. As such a sample size of 384 is needed for this study in which 230 valid responses is adequate for data analysis (Moser & Kalton, 1971). The findings are presented in tables and pictures. Table 4.1 shows the summary of data preparation and reliability. Three hundred eighty-four (465) questionnaires were administered to the research population, and three hundred fifty (350) questionnaires (75%) were retrieved. After that, the data was imported into SPSS for analysis to assess its reliability. The main purpose of the reliability test is to assess the reliability and internal consistency of the overall research data. Generally, the reliability in terms of Cronbach Alpha for the entire data (0.725) is good because it is greater than 0.500.

Table 4.1: Summary of Data Preparation and Reliability

Total Responses			**Cronbach Alpha**
Sent	**Received**	**Response Rate**	
465	350	75%	0.725

RESULTS AND DISCUSSION

Current Challenges faced by office buildings in the context of energy consumption

The results of the mean item score (MIS) employed to rate the perceptions of the respondents current challenges faced by office buildings in the context of energy consumption are summarised in Table 4.2.

Table 4.2: Current Challenges Faced by Office Buildings in the Context of Energy Consumption

S/NO	Statements	S.D(1)	D.A(2)	N (3)	A (4)	S.A (5)	Mean	Rank	Decision
C1	Do you agree that the energy use and activities in office buildings in Abuja lead to increase in the amount spent on fuel?		3(0.9)	41(11.7)	248(70.9)	58(16.6)	4.32	1st	Agree
C2	Do you agree that lack of awareness on how green building can reduce energy consumption make it		3(0.9)	75(21.4)	221(63.1)	51(14.6)	4.28	2nd	Agree

	difficult for implementation?								
C3	Do you agree that the energy consumption of office buildings in Abuja result in high electricity tariff?		4(1.1)	54(15.4)	243(69.4)	49(14.0)	4.26	3rd	Agree
C4	Do you agree that the office buildings in Abuja require sufficient measures to reduce the impact of activities on their total energy consumption?		4(1.1)	49(14.0)	248(70.9)	49(14.0)	4.26	3rd	Agree
C5	Do you agree that the current design and construction practices of office buildings in Abuja need to address high energy consumption?		3(0.9)	53(15.1)	246(70.3)	48(13.7)	4.26	5th	Agree
C6	Do you agree that the energy consumption of office buildings in Abuja contributes to an increased carbon footprint?	3(0.9)	4(1.1)	41(11.7)	259(74.0)	43(12.3)	4.21	6th	Agree
C7	The office building I work in faces challenges related to high energy consumption?		54(15.4)	69(19.7)	179(51.1)	46(13.1)	4.09	7th	Agree
	Average MIS						***4.24***		Agree

Key: S.D(1) = Strong-ly disagree, D.A(2) = Disagree, N (3) = Neutral, A (4) = Agree, S.A(5) = Strongly Agree)

Table 4.2 shows the perceptions of the respondents about the current challenges faced by office buildings in the context of energy consumption. The respondent agreed that the energy use and activities in office buildings in Abuja lead to an increase in the amount spent on fuel and agreed that a lack of awareness on how green buildings can reduce energy consumption makes it difficult for implementation (MIS = 4.32 and 4.28, ranked 1st and 2nd, respectively). This was followed by the fact that the energy consumption of office buildings in Abuja results in a high electricity tariff and that the office buildings in Abuja require sufficient measures to reduce the impact of activities on their total energy consumption (MIS = 4.26 and 4.26, ranked 3rd, respectively).

Finally, the office building I work in faces challenges related to high energy consumption (MIS = 4.09).

Potential benefits of green architecture principles of office buildings in Abuja

The results of the Mean Item Score (MIS) employed to rate the perceptions of the respondents on the potential benefits of green architecture principles in office buildings in Abuja are summarised in Table 4.3.

Table 4.3: Potential Benefits of Green Architecture Principles of Office Buildings in Abuja

S/NO	Statements	S.D(1)	D.A(2)	N (3)	A (4)	S.A (5)	Mean	Rank	Decision
B1	Do you agree that office buildings with indoor plants and green walls can improve the health of users?	-	9(2.6)	68(19.4)	227(64.9)	45(12.9)	4.23	1st	Agree
B2	Do you agree that designing office spaces with natural ventilation systems and openable windows can lower artificial energy consumption for ventilation and cooling in Abuja?	-	10(2.9)	80(22.9)	215(61.4)	44(12.6)	4.22	2nd	Agree
B3	Do you agree that implementing natural lighting and daylight harvesting systems in office buildings can boost productivity and job satisfaction among occupants?	-	8(2.3)	107(30.6)	194(55.4)	41(11.7)	4.21	3rd	Agree
B4	Do you agree that incorporating solar panels can effectively mitigate the impact of climate change in office buildings in Abuja?	-	10(2.9)	77(22.0)	231(66.0)	32(9.1)	4.15	3rd	Agree
B5	Do you agree that the overall performance of office buildings in	-	14(4.0)	236(67.4)	71(20.3)	29(8.3)	4.13	5th	Neutral

	Abuja can be enhanced by implementing green roofing systems and urban green spaces?								
B6	To what extent do you agree that rainwater harvesting systems can reduce building maintenance costs in office buildings in Abuja	-	15(4.3)	238(68.0)	68(19.4)	27(7.7)	4.10	6th	Neutral
	Average MIS						***4.17***		**Agree**

Key: S.D(1) = Strongly disagree, D.A(2) = Disagree, N (3) = Neutral, A (4) = Agree, S.A(5) = Strongly Agree)

Table 4.3 shows the perceptions of the respondents about the potential benefits of green architecture principles for office buildings in Abuja. The respondent agreed that office buildings with indoor plants and green walls can improve the health of users and that designing office spaces with natural ventilation systems and openable windows can lower artificial energy consumption for ventilation and cooling in Abuja (MIS = 4.23 and 4.22, ranked 1st and 2nd, respectively). This was followed by the fact that implementing natural lighting and daylight harvesting systems in office buildings can boost productivity and job satisfaction among occupants and that incorporating solar panels can effectively mitigate the impact of climate change in office buildings in Abuja (MIS = 4.21 and 4.15, ranked 3rd and 4th, respectively). Finally, the rainwater harvesting systems can reduce building maintenance costs in office buildings in Abuja (MIS = 4.10).

The need for green architecture policies on office buildings in Abuja

The results of the Mean Item Score (MIS) employed to rate the need for green architecture policies on office buildings in Abuja are summarized in Table 4.6.

Table 4.4: The Need for Green Architecture Policies on Office Buildings in Abuja

S/NO	Statements	S.D(1)	D.A(2)	N (3)	A (4)	S.A (5)	Mean	Rank	Decision
N1	Do you agree that green architecture policies should be enforced in Nigeria?		7(2.0)	53(15.1)	213(60.9)	76(21.7)	4.40	1st	Agree
N2	Do you agree that green architecture		8(2.3)	17(4.9)	252(72.0)	73(20.9)	4.39	2nd	Agree

	policies should reflect in building approvals?		
	Average MIS	***4.39***	Agree

Key: S.D(1) = Strongly disagree, D.A(2) = Disagree, N (3) = Neutral, A (4) = Agree, S.A(5) = Strongly Agree)

Table 4.4 shows the perceptions of the respondents about the need for green architecture policies on office buildings in Abuja. The respondent agreed that green architecture policies should be enforced in Nigeria (MIS = 4.40, ranked first). This was followed by the fact that green architecture policies should reflect in building approvals (MIS = 4.39, 2nd).

Office Environment in Relation to the following Green Architecture

The results of the Mean Item Score (MIS) employed to rate the present office environment in relation to the following green architecture principles are summarized in Table 4.5.

Table 4.5: Office Environment in Relation to the Following Green Architecture

S/NO	Office environment in relation to the following green architecture	Mean	Rank	Decision
1	Natural lighting	3.44	1st	good
2	Natural ventilation	3.31	2nd	good
3	Water savings sanitary and plumbing appliance	2.85	3rd	good
	Soft landscape	2.73	4th	good
4	Green walls	1.98	5th	Fair
5	Use of solar panels	1.68	6th	Fair
6	Water features (fountains, pools)	1.55	7th	Fair
	Average MIS	***2.50***		***Fair***

Key: 5= Excellent, 4 = Very good, 3 = Good, 2 = Fair, 1= Poor

Table 4.5 shows the present office environment in relation to the following green architecture principles: The respondent agreed that the office environment in relation to the following: natural lighting, natural ventilation, water-saving sanitary and plumbing appliances, and soft landscape (MIS = 3.44, 3.31, 2.85, and 2.73 and ranked 1st, 2nd, 3rd, and 4th) is good. While the office environment in relation to the following green walls, use of solar panels, and water features (fountains, pools) (MIS = 1.98, 1.68, and 1.55 and ranked 5th, 6th, and 7th) are fair, on average, all the office environments in relation to natural lighting, natural ventilation, water-saving sanitary

and plumbing appliances, soft landscape, green walls, use of solar panels, and water features (fountains, pools) are good (MIS = 2.50).

CONCLUSION AND RECOMMENDATION

This research is aimed at integrating the principles of green architecture into Abuja's office design with the goal of improving artificial energy consumption. Results from this study show that all the people who took part agreed on what effect energy use and operations have on office buildings in Abuja, which leads to higher fuel costs. In addition, they all agreed that it is hard to put green buildings into practise because there isn't enough information about how they can help reduce energy use. The study concluded that integrating green architecture principles is necessary for improving artificial energy consumption in the design of office buildings. The study recommends that designers should ensure the implementation of proper design and orientation, leveraging climatic conditions and the use of more efficient equipment, which helps to reduce energy consumption, consequently leading to a reduction of energy bills, improved indoor air quality, and lower carbon emissions. Architects should also consider the life-cycle perspective of the building, including embodied energy use and operational processes, to reduce carbon emissions in order to provide the design of office buildings that are energy-efficient, environmentally friendly, and sustainable.

REFERENCES

Adewolu, A. O. (2023). Green Building Certification in Nigeria: A Comparative Study of Selected Rating Systems. *International Journal of Engineering Inventions, 12(5), 233-240.*

Bungau, C. C., Bungau, T., Prada, I. F., & Prada, M. F. (2022). Green Buildings as a Necessity for Sustainable Environment: Dilemmas and Challenges. MDPI

Dabara, D. I., Akinyemi, A. P., Adekunle, A. O., Omotehinshe, O. J., & Ankeli, A. I. (2017). The Need For Green Building Rating Systems Development For Nigeria: The Process, Progress And Prospect.

Davenport, C. (2018). Major climate report describes a strong risk of crisis as early as 2040. The New York Times, 7.

David, O.N. & Olabode, E.O. (2015). Stakeholders perception of factors determining the adoptability of green building practices in construction project in Nigeria. *Journal of Environment and Earth Sciences, 5*(2), 2225-0948.

Erebor, E. M., & Adedire, F. M. (2023). Factors Influencing the Use of Low Carbon Emissivity Features and Strategies in Office Buildings. *Journal of Economics and Sustainable Development, 14(11), 1-10.*

Erebor, E. M., Ibem, E. O., Ezema, I. C., & Sholanke, A. B. (2022). Building Professional

Practices Knowledge and Integration Levels of Energy Efficiency Design Features in Selected Office Buildings in Abuja, Nigeria. Environment

Hor, K., & Rahmat, M. K. (2018). Analysis and recommendations for building energy efficiency financing in Malaysia. *Energy Efficiency, 11(1), 79-95.*

Idris, H. A., & Dawi, G. J. (2019). Potentials of Integrated Smart Façade for Office Buildings in Abuja: A Green Retrofitting Perspective. *Journal of Applied Sciences and Environmental Sustainability, 5(11), 1-14.*

Jegede, F. O., Oyedele, L. O., Akinade, O. O., Bilal, M., Owolabi, H. A., & Ajayi, A. O. (2021). Evaluation of the use of Green Façade in Residential Buildings in Kubwa, Abuja, Nigeria. *IOP Conference Series: Materials Science and Engineering, 1107,* 012185.

Kats, G. (2003). *Benefits of green buildings:* A report to California's sustainable building task force, 12-19.

Khalifa, A., Nour, W., & Elghamry, R. (2023). The Impact of Using Smart Windows Technique in Reducing Energy Consumption and Improving Building Performance in the Office Building. *Journal of Engineering Research, 7*(4), 57-64. doi: 10.21608/erjeng.2023.323547

Krejcie, R. V., & Morgan, D. W. (1970). Determining Sample Sizes for Research Activities. Educational and Psychological Measurement, 30(3), 607-610.
Majid, R. A., Said, R., & Barau, I. S. (2023). Examining green attribute preferences in residential buildings: A study in Kano, Nigeria. *Planning Malaysia: Journal of the Malaysian Institute of Planners*, *21*(5), 309-324.
Mosa, C.A., & Kalton, G. (1971). Survey methods in social investigation (1st ed.). London, UK: Routledge. Retrieved from https://doi.org/10.4324/9781315241999
Said, R., Majid, R. A., Alias, A., Adnan, Y. M., Razali, M. N. (2016). Sustainable housing affordability in Sabah. *Planning Malaysia* (5), 65-76.
Said, R., Majid, R. A., Daud, M. N., Esha, Z., Razali, M. N. (2017). Owners' perception towards sustainable housing affordability in Kuching, Sarawak. *Journal of Design and Built Environment*, 17, 194-206.
Said, R., Majid, R. A., Pey, K. C., & Olanrele, O. O. (2020). Ascertaining the business sustainability of heritage properties in Malaysia. *International Real Estate Review*, *23*(4), 1163-1185.
Xu, S., Li, G., Zhang, H., Xie, M., Mendis, T., & Du, H. (2023). Effect of Block Morphology on Building Energy Consumption of Office Blocks: A Case of Wuhan, China. Buildings, 13(3), 768. https://doi.org/10.3390/buildings13030768
Musa, A.A.R. and Abdullahi, A. (2018). Office Buildings in Tropical Composite Climatic Belt of Abuja, Nigeria. Dutse Journal of Pure and Applied Sciences, 4(2), 551-564.
Zuo, J., & Zhao, Z. Y. (2014). Green building research-current status and future agenda: A review. *Renewable and Sustainable Energy Reviews*, *30*, 271-2.