NIU Journal of Humanities Copyright©2023
Nexus International University ISSN: *3007-1704*; 8(4): 139–145

Assessment of Architecture Students' Knowledge of Passive Design Strategies in Academic Buildings in a Typical Nigerian Private University

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Abstract. Buildings use more than 40% of the energy consumed worldwide. This has prompted the development of numerous strategies to guarantee that buildings can still function maximally with reduced energy use. The concept of passive design strategies has been widely employed in architectural professional practice to ensure the reduction of building energy usage is kept to a minimum and enhance building performance. In architectural design training, however, despite the study of building climatology, several students are still seen designing buildings in tropical climates with little adoption of passive design strategies. To this end, this study aims at assessing the knowledge level of graduate architecture students at Lead City University, Ibadan, Oyo State of passive design strategies in academic buildings. The case study research approach was used, and respondents were chosen through random sampling. A total of 84 students were given structured questions to answer in order to collect primary data. Data were analysed using frequencies and percentages in SPSS, and the results were presented using tables. Respondents' level of awareness and importance of the various concepts associated with passive design in academic buildings were considered. The study revealed that respondents have good knowledge about passive design strategies. Building materials, day lighting, and natural ventilation were identified as the most crucial among the passive design strategies used for academic buildings in achieving users' comfort and reducing energy conservation. Also, building mass was observed to be considered the least important among the passive design strategies.

Keywords: Academic building, Architecture students, Design strategies, Passive design, Thermal comfort.

1. Introduction

Buildings are designed with the intent of providing a comfortable internal atmosphere that meets occupants' satisfaction and wellbeing with minimal energy use [1]. Buildings account for 40% of total global energy use and one-third of global greenhouse gas (GHG) emissions [1,2]. Academic buildings are not left out of these building types as they serve as the physical learning environment. In response to ensuring the thermal comfort of building users, the adoption of heating, ventilation, and air conditioning installations has proliferated in the built environment, accounting for a sizeable amount of energy consumption. In tropical regions such as Nigeria, there is an expansion of higher education institutions as a result of population growth, and consequently, the energy usage in the building sector is enormous and is predicted to increase [2]. In addition, the impact of climate change and urbanization has brought about an increase in reliance on active energy sources or mechanical technologies.

The need to attain good thermal comfort in the tropics through the use of natural means has prompted the development of numerous strategies to guarantee that buildings can still function maximally with lower energy consumption. Passive design strategies have been widely employed in architectural professional practice to ensure the reduction of building energy consumption and enhance building performance. Several studies have been carried out globally on the use of passive design approaches [3, 4]. Examples of passive design concepts and principles, according to Ibem et al. [2], influencing users thermal comfort are: building orientation, building material, building mass, day lighting, indoor space quality, indoor air quality, landscaping, natural ventilation, and sun shading devices. Similarly, James, Fulani, and Azoji [5]. considered passive cooling principles in hotels such as building orientation, building form, natural ventilation, shading devices, landscaping, materials and finishes, and thermal insulation.

In architectural education, building climatology is taught under the environmental control systems course modules. It is observed that despite the study of building climatology, among others, several students are still seen designing buildings in tropical climates with little adoption of passive design strategies. Designs are done more by students adopting the temperate approach, with a high reliance on active energy and more emphasis placed on building aesthetics. To this end, this study aims at assessing the knowledge level of graduate architecture students at Lead City University, Ibadan, Oyo State, about passive design strategies in academic buildings. The key objectives in achieving this study are to: i) assess the respondents' level of awareness of the passive design concept; and ii) assess the respondents' level of importance of passive design strategies in the thermal comfort of academic buildings.

2. Literature Review

2.1 Academic Buildings

Coulson et al.[6]. classified university campus design as a civic art form. For effective campus planning for student satisfaction and academic performance, planning concepts in urban and regional planning that can be adopted include the close-kint concept, the segregated concept, the loose-tie concept, and the ring concept [7]. Irrespective of the planning concept type adopted, the four classifications of building types on a university campus are academic buildings, administrative buildings, sports facilities, and students' hostels. The Faculty of Architecture building considered in this study can be classified as an academic building.
Higher education institutions can only function effectively when all the required resources—financial, physical, and human—are made available [8]. Among other physical resources, academic buildings are crucial physical resources for the efficient operation and productivity of the teaching and learning process [9].

One of the requirements of a world-class university is the presence of high-quality structures and facilities on its campus, which are contained in the provision of a high-quality and supportive research and educational environment for both staff and students [10, 11].

2.2 Passive Design Strategies

The utilization of energy in buildings has been the subject of extensive global investigation. Buildings have seen a rapid increase in energy usage in recent years as a result of population growth, industry development, city growth, and improved living standards [12]. The aforementioned causes are anticipated to lead to an increase in thermal comfort and indoor air quality demand. According to Sun, Gou, and Lau [13] and Soflaei et al. [14], the energy utilized in the building sector accounts for between 20.1% to 40% of all energy delivered globally and 30% of all greenhouse gas emissions. Due to better knowledge of how many resources buildings use and their environmental impact, the building sector has been the focus of energy efficiency regulation and climate change. Making existing structures more energy efficient is one of the best strategies to reduce energy usage in the construction sector. Consequently, several nations and global organizations have invested greatly in improving the energy efficiency of current buildings [13].

Numerous studies have shown that the HVAC (heating, ventilation, and air conditioning) system accounts for the majority of the energy used in buildings. As a result, a sizeable portion of building energy-related studies have concentrated on methods to boost the effectiveness and performance of HVAC systems while using less energy. Retrofits to the lighting systems of older buildings have a substantial potential to reduce energy consumption in addition to HVAC. For retrofitting older buildings, it is important to consider lighting controls, lighting system upgrades, and daylighting optimization [15]. Many studies have been conducted on glazing upgrades that aim to reduce heat gain during the summer or loss during the winter.

In general, passive and active options for energy efficiency retrofitting can be distinguished. While active solutions focus on improving heating, ventilation, HVAC systems, lighting, and any other building services applications, passive solutions seek to create more energy-efficient architectural components to lessen dependency on them. According to a study [16], compared to the potential benefit of energy savings, passive solutions frequently have a modest additional capital investment cost. As a result, passive design is encouraged by a number of green and sustainable design principles [17].

Academic buildings are not exempt from the importance of passive design in maintaining a sustainable built environment. The phrase "passive design" describes a type of architecture that relies less on mechanical heating, cooling, and lighting systems and instead makes use of the environment and natural forces to maintain a comfortable temperature inside a building [18]. For passive design to be favorable and successful, two crucial considerations must be made: climate and comfort. Passive design makes use of natural energy flows by using particular techniques and strategies to preserve thermal comfort [18, 19, 4].

These passive design principles can also be supplemented by a number of features, like the use of technology and specialized controls, to improve health and welfare in the built environment. According to Huo et al. [17], the primary objective of passive design is to seamlessly incorporate structures into the cycles of nature. In order to maximize human comfort, the building envelope acts as a partition between the actual and virtual climates throughout the design. Some of the main elements that affect human comfort include visual, thermal, and auditory comforts. Building envelopes are essential for providing the proper level of comfort, along with the technology utilized.

These technologies, which make our conveniences possible, can be active, passive, or hybrid in nature—a combination of the two. Passive technologies are systems that rely on renewable resources and enable us to maintain comfort levels without using artificial energy.

Some key passive design concepts according to Ibem et al.'s [2] are: building orientation, building material, building mass [21], day lighting [15], and indoor space quality. Others are indoor air quality [22], landscaping, natural ventilation, and sun shading devices.

3. Research Methodology

The case study research design was adopted as the study focused only on the graduate students of the department of architecture at Lead City University, Ibadan, Oyo State, Nigeria. This category of students was selected based on the fact that they have undergone all necessary undergraduate courses in architectural training, interacted with academic buildings, and experienced the mandatory student industrial training, which affords students of architecture the requisite industry exposure.

The study adopted Ibem et al.'s (2019) conceptual framework used in a similar study on terminal buildings, and the passive design concepts were assessed. The study population is a total of 84 students, and the same is adopted as the sample size for the study considering their limited number. Consequently, primary data were obtained through structured questions administered to a total of 84 in a random sampling approach by the researchers in the first week of June 2023. A total of 56 valid responses were achieved. This is approximately 67% of the total administered questionnaire through electronic distribution. Data were analysed using descriptive statistics in SPSS, and the results were presented using tables.

4. Results and Discussion

4.1 Demographics of respondents

Table 1 presents the demographics of respondents in frequencies and percentages.

Table 1 show that 69.6% of the respondents were male, while 30.4% were female. This is not surprising given the predominance of men in the architectural profession. The age group of respondents shows that none were below 20 years old; the majority (44.7%) are between the ages of 21-30years. Also, 32.2% were between the ages of 31-40years, while 14.2% belong to the age category 41-50 years, and 8.9% were 51 and above. The respondents' age distribution shows that the majorities is above 20 years of age, as expected for graduate students, and have the capacity for independent assessment. Their highest academic qualification shows that 78.6% of the students have the B.Sc. qualification; while 21.4% have their master's. This suggests that the masters are either in related discipline or students are doctoral candidates in the department. Their level of qualification in architecture shows that the students have been taught basic building climatology requirements as undergraduates as well as industrial experience for the practical application of passive design concepts. Table 1 presents the demographics of respondents in frequencies and percentages.

Table 1: Demographics of respondents

		Frequency (56)	Percentage (%)
Gender	Male	39	69.6
	Female	17	30.4
Age Group	20 years and below	0	0
	21 -30 years	25	44.7
	31 -40 years	18	32.2
	41 - 50 years	8	14.2
	51 and above	5	8.9
Highest Academic Qualification	B.Sc.	44	78.6
	M.Sc.	12	21.4

Respondents' assessment of level of awareness of the passive design concepts

The participants' responses on their level of awareness of the passive design concepts are grouped under three possible answers of "Not Aware", "Not Sure" and "Aware". The result is presented in Table 2.

The result in Table 2 shows that most (78.57%) of the respondents are aware of building orientation as a passive design strategy, while some (21.43%) are not aware. None was found to be not sure of their opinion.

Table 2. Respondents' assessment of level of awareness of the passive design concepts

Passive Design Concepts	RESPONDENTS' ASSESSMENT		
	Group	frequency	Percentage (%)
1. Building Orientation	Not Aware	12	21.43
	Not sure	0	0
	Aware	44	78.57
	Total	56	100
2. Building Material	Not Aware	12	21.43
	Not sure	2	3.57
	Aware	42	75.00
	Total	56	100
3. Building Mass	Not Aware	11	19.64
	Not sure	19	33.93
	Aware	26	46.43
	Total	56	100
4. Day lighting	Not Aware	9	16.07
	Not sure	2	3.57
	Aware	45	80.36
	Total	56	100
5. Indoor Space Quality	Not Aware	14	25.00
	Not sure	0	0
	Aware	42	75.00
	Total	56	100
6. Indoor Air Quality	Not Aware	12	21.43
	Not sure	7	12.50
	Aware	37	66.07
	Total	56	100
7. Landscaping	Not Aware	9	16.07
	Not sure	5	8.93
	Aware	42	75.00
	Total	56	100
8. Natural Ventilation	Not Aware	12	21.43
	Not sure	0	0
	Aware	44	78.57
	Total	56	100
9. Sun Shading Device	Not Aware	10	17.86
	Not sure	2	3.57
	Aware	44	78.57
	Total	56	100

On respondents' awareness of choice of building material as a passive design strategy, again majority (75.00%) are aware, while some (21.43%) are not aware. Just a few (3.57%) are not sure if they are aware or not. Similarly, most

(80.36%) of the respondents are aware of day lighting as a passive design strategy, while some (16.07%) are not aware. A few (3.57%) are not sure of this strategy.

The data in Table 2 also reveals that majority (75.00%) of the respondents are aware of indoor space quality as a passive design strategy, while the remaining (25.00%) are not aware. In the assessment of indoor air quality, a larger fraction (66.07%) of the respondents is aware, some (21.43%) are not aware, while a few (12.50%) are not sure. On landscaping as a passive design strategy, most (75.00%) of the respondents are aware, while some (16.07%) are not aware, and a few (8.93%) are not sure. Similarly, on natural ventilation and sun shading device as a passive design strategy, most (78.57%) are aware, while some (21.43% and 17.86% respectively) are not aware. Just a few (3.57%) are not sure of sun shading device as a passive design strategy.

Contrary to the results of other passive design strategies, about half (46.43%) of the respondents are aware building mass as a passive design strategy, while some (19.68%) are not aware. The remaining (33.93%) of the respondents are not sure. This result suggests that more attention needs to be given to the teaching of building mass as a passive design strategy in architectural education.

Respondents' assessment of level of awareness of the passive design concepts

The participants' responses on their level of importance of the passive design concepts are grouped under three possible answers of "Not Understood", "Not Sure" and "Understand". The result is presented in Table 3.

Table 3. Respondents' assessment of level of Importance of the passive design concepts to academic buildings

Passive Design Concepts	RESPONDENTS' ASSESSMENT		
	Group	frequency	Percentage (%)
1. Building Orientation	Not Important	8	14.29
	Not sure	2	3.57
	Important	46	82.14
	Total	56	100
2. Building Material	Not Important	7	12.50
	Not sure	0	0
	Important	49	87.50
	Total	56	100
3. Building Mass	Not Important	8	14.29
	Not sure	19	33.93
	Important	29	51.79
	Total	56	100
4. Day lighting	Not Important	7	12.50
	Not sure	0	0
	Important	49	87.50
	Total	56	100
5. Indoor Space Quality	Not Important	5	8.93
	Not sure	7	12.5
	Important	44	78.57
	Total	56	100
6. Indoor Air Quality	Not Important	6	10.71
	Not sure	7	12.50
	Important	43	76.79
	Total	56	100
7. Landscaping	Not Important	8	14.29
	Not sure	2	3.57
	Important	46	82.14
	Total	56	100
8. Natural Ventilation	Not Important	7	12.50
	Not sure	0	0
	Important	49	87.50
	Total	56	100
9. Sun Shading Device	Not Important	7	12.5
	Not sure	0	0
	Important	49	87.50
	Total	56	100

The result in Table 3 shows that most (82.14%) of the respondents considers building orientation as a passive design strategy to be important to academic buildings, while some (14.29%) considers it as not important. A few (3.57%) of the respondents was found not sure of their opinion. On respondents' importance of choice of building material as a passive design strategy to academic buildings, again majority (87.50%) considers it important, while the remaining (12.50%) considers it not important. Similarly, most (87.50%) of the respondents considers Day lighting, Natural Ventilation, and Sun Shading Device, respectively as important passive design strategy in academic buildings, while the remaining (12.50%) considers them as not important respectively.

The data in Table 3 also reveals that majority (78.57%) considers indoor space quality as an important passive design strategy for academic buildings, while some (8.93%) considers it as not important, and others (12.5%) are not sure of its importance. In the assessment of indoor air quality, most (76.79%) of the respondents considered it an important passive design strategy for an academic building, some (10.71%) considered it not important, while others (12.50%) are not sure.

Also on landscaping, most (82.14%) of the respondents considers it an important passive design strategy relevant to an academic building, while some (14.29%) considers it as not important, and a few (3.57 %) are not sure.
Contrary to the results of other passive design strategies important to academic buildings, about half (51.79%) of the respondents considers building mass as important, while some (14.29%) considers them not important. The remaining (33.93%) of the respondents are not sure of its importance to academic buildings. This result suggests that the respondents have a good understanding of the importance of passive design strategy in relation to academic buildings.

5. Conclusion

In this study, passive design principles utilized in academic buildings were assessed to determine the amount of knowledge held by graduate students in the architecture department at the leading city university, Ibadan, Oyo State. The study's findings showed that graduate students had an excellent understanding of all of the strategies examined. The right harnessing of daylighting, planning to accommodate natural ventilation, and proper landscaping of the setting were among the strategies used for the passive design of academic buildings, while proper building orientation was given more weight. However, it has been noted that building mass is not prioritized. This could be a result of a lack of comprehension of this strategy. The results of this study mostly align with Ibem et al.'s (2019) assertion regarding the value of passive design techniques in terminal buildings. This demonstrates that, regardless of the type of building, the use of passive design is crucial for regulating the microclimate and ensuring user comfort.

References

A. Ahmed, M. Mateo-Garcia, A. Arewa, and K. Caratella, "Integrated Performance Optimization of Higher Education Buildings Using Low-Energy Renovation Process and User Engagement", Energies, 14(5), 1475, 2021.(Article)

E. O. Ibem, B. E. Udezi, O. M. Oti, and O. A. Fakorede, "Assessment of Architects' Knowledge of Passive Design Strategies in Terminal Buildings among Architectural Firms in Lagos State", In IOP Conference Series: Materials Science and Engineering (Vol. 640, No. 1, p. 012038). IOP Publishing. November 2019. (Conference paper)

B. Ozarisoy, "Energy effectiveness of passive cooling design strategies to reduce the impact of long-term heatwaves on occupants' thermal comfort in Europe: Climate change and mitigation", *Journal of Cleaner Production*, 330, p.129675, 2022 (Article)

P. A. ALI, "Energy reduction through architectural passive designs in sulaymaniyah, Northern Iraq: Building's material assessment" (Doctoral dissertation, NEAR EAST UNIVERSITY), 2021.

M.E. James, O.A. Fulani, and C.F Azoji, "Application of Passive Cooling Principles in Selected Hotel Buildings in Southwest Nigeria", In IOP Conference Series: Earth and Environmental Science (Vol. 1054, No. 1, p. 012032). IOP Publishing. September, 2022 (Conference paper)

J. Coulson, P. Roberts, and I. Taylor, University planning and architecture: The search for perfection. Routledge, 2015. (Book)

K. G. Jiriko, "Commuting Monitory Cost of Operating Multi-Campus Organisation Structure and their Implication/Effect on Student's Learning in Kaduna Polytechnic, Kaduna-Nigeria", 2014 (Article)

S. Muhammad, M. Sapri, and I. Sipan, “Academic buildings and their influence on students’ wellbeing in higher education institutions”, Social indicators research, 115, 1159-1178, 2014. (Article)

F. A. Mustafa, “Performance assessment of buildings via post-occupancy evaluation: A Case Study of the building of the architecture and software engineering departments in Salahaddin University-Erbil, Iraq”, Frontiers of Architectural Research, 6(3), 412-429, 2017 (Article)

D. Papandrea, Does campus beauty matter?2015 Retrieved on 17th May 2019 from https://universitybusiness.com/does-campus-beauty-matter/

O. Obaleye, S. Akintunde, E. Opaluwa, S. Tongo, A. Babamboni, and A. Ejoor, “Post occupancy evaluation of architecture department building in a Nigerian private university”, In INTED2022 Proceedings (pp. 8783-8790). IATED, 2022. (Conference paper)

J. Litardo, M. Palme, M, R. Hidalgo-León, F. Amoroso, and G. Soriano, “Energy saving strategies and on-site power generation in a university building from a tropical climate”, *Applied Sciences*, 11(2), 542, 2021(Article)

X. Sun, Z. Gou, and S.S.Y. Lau, “Cost-effectiveness of active and passive design strategies for existing building retrofits in tropical climate: Case study of a zero energy building”, *Journal of Cleaner Production*, 183, 35-45.2018 (Article)

F. Soflaei, M. Shokouhian, H. Abraveshdar, and A. Alipour, “The impact of courtyard design variants on shading performance in hot-arid climates of Iran”, Energy and Buildings, 143, 71-83, 2017. (Article)

I. Acosta, C. Munoz, M.A. Campano, and J. Navarro, “Analysis of daylight factors and energy saving allowed by windows under overcast sky conditions”, Renewable Energy 77, 194-207, 2015. (Article)

A. Jafari, A. Haghighi Poshtiri, “Passive solar cooling of single-storey buildings by an adsorption chiller system combined with a solar chimney”, *Journal of Cleaner Production* 141, 662-682, 2017.(Article)

X. Huo, A.T.W. Yu, Z. Wu, “A comparative analysis of site planning and design among green building rating tools”, *Journal of Cleaner Production* 147, 352-359, 2017. (Article)

T. Riotama, and H. Herdiansyah, “Passive design implementation as sustainable development approach on vertical housing case study: Sentra Timur Residence”, In IOP Conference Series: *Materials Science and Engineering* (Vol. 703, No. 1, p. 012032, 2019). IOP Publishing.(Conference paper)

N. Akhimien, E. Latif, and S. Hou, Exploring passive design and circular economy strategies in tropical West Africa, 2020 (Standards and Reports)

O.O. Joseph, A.B. Adeboye, I.C. Ezema, and E. Opaluwa, “Shapes and aesthetic perception: A case study of university of Lagos Senate building façade”, *International Journal of Scientific & Technology Research*, 9(03), 765, 2020.(Article)

A. Ejoor, O.J. Obaleye, A. Oniare, S. Ajijola, and O.O. Ajayi, "Experts' Identification of Post-Occupancy Evaluation Concepts Relevant to Building Performance", *Caleb International Journal of Development Studies*, 4(2), 150-172., 2021, DOI: 10.26772/cijds-2021-04-02-08 (Article)