Journal of Capital Development in Behavioural Sciences Vol. 12 Issue 2 (September, 2024)
Faculty of Arts & Education, Lead City University, Ibadan, Nigeria
***ISSN Online:** 2449-0679 **ISSN Print:** 2354-3981*

Assessment of Architectural Student Perception on Energy Efficiency in Architectural Designs in Selected Tertiary Institution in Lagos Mega-city, Nigeria

[1]Akintunde O. ONAMADE,
[2]Opeyemi A. ASAJU,
[3]Bamidele J. ADEWUMI,
[4]Michael OGUNRAYEWA
[5]Oluwole, A. ALAGBE
Department of Architecture, Caleb University, Lagos, Nigeria
onamadeakintunde@gmail.com, aj.ope.oa@gmail.com,
Enitan.itan2006@gmail.com, mboadegbile@yahoo.com,
oluwole.alagbe@calebuniversity.edu.ng
[1]+234 803 327 9824,[2]+234 803 328 9308&[3]+234 809 067 3273

Abstract
This study assessed the architectural students' perceptions of energy efficiency in architectural designs in selected tertiary institutions in Lagos Mega-city. Thelevel of awareness of architectural students incorporating energy efficiency into architectural designs through active design strategies than passive design strategies was also assessed and their knowledge on how energy sustainability could be achieved inarchitectural design was investigated. The researchcontributed to the development of strategies for improving students' awareness and engagement in sustainable building practices. A cross-sectional survey approach was adopted in this study, a quantitative data was randomly collected from108 architectural students in selected tertiary institutionsand data analysed using Statistical Package for Socio-Sciences (SPSS).The study findings showed that 30.5% of respondents are aware while 69.5% are not aware of incorporating energy efficiency into architectural design.Also 69.4% are have the knowledge of the need to incorporate energy sustainability into architectural design while 14.8% are not knowledgeable and 14.8% were not sure.The study recommended that student awareness should be intensifiedand promoted both in their training and in the curriculum of architectural designs and sustainable building practices.

Keywords: Architectural students, Architectural designs, Energy efficiency, Perception assessment, Tertiary institution.

Introduction

Energy efficiency is a crucial aspect of modern architecture as it contributes significantly to environmental sustainability and reduces energy consumption(Adewumi, Onamade, Asaju, & Adegbile, 2023). This has become a growing concern within the built environment about the impact of buildings on the environment and the need for sustainable design practices. According to the International Energy Agency (IEA), the building sector accounts for approximately 40% of global energy consumption and about one-third of greenhouse gas emissions (IEA, 2020). This highlights the critical role of architects in designing buildings that are energy-efficient and environmentally sustainable. It is however required that architectural students should be well equipped with skills for designing a sustainable energy efficient building if this concept will be achieved(Asaju, Adewumi, Onamade & Alagbe., 2024).

Therefore, the perception of architectural students toward energy efficiency in architectural design is an important area of research that has received attention in recent years. Kamaruzzaman, Egbu, Zawawi, & Abdul-Malek (2018), examined the role of architectural education in promoting sustainable design and energy efficiency, and in his opinion the role of architectural education cannot be overemphasized. As such, understanding the perception of architectural students towards energy efficiency is crucial in developing effective strategies to promote sustainable design practices(Asaju, Onamade, Chukwuka & Odefadehan, 2024). Architectural education plays a crucial role in promoting sustainable design practices among architects. Though, there is a growing concern about the adequacy of the current architectural education curriculum in preparing students to design energy-efficient buildings (*Tavsanoglu et al., 2016*). Previous research studies have explored the perception of architectural students toward sustainable design practices. For instance, Kamaruzzaman et al. (2018) found that architectural students had a positive attitude toward sustainable design practices but lacked the necessary knowledge and skills to design sustainable buildings. Similarly, Tavsanoglu et al. (2016) found that the

current architectural education curriculum did not adequately address the principles of sustainable design.

The assessment of architectural student perception of energy efficiency in architectural designs in selected tertiary institutions seeks to build on the existing body of knowledge and provide insights into the current state of architectural education and its role in promoting sustainable design practices. The research study focuses on three selected tertiary institutions offering architecture with clearly defined objectives;firstly, to identify the demographic characteristics of the respondents towards energy efficiency in architectural designs, secondly assessing the level of awareness of architectural students incorporating energy efficiency into architectural designs through active design strategies than passive design strategies. Thirdly, to investigate thestudents' knowledge on how energy sustainability could be achieved inarchitectural design and finally, examine the relationship between student's awareness of incorporating active and passive design strategies and Students' knowledge on energy sustainability into architectural designs. This research is significant as it will provide insights into how to improve the energy efficiency of buildings in the future and enhance the curriculum of architectural education. It will also contribute to the existing body of knowledge on sustainable design and promote sustainable design practices in architecture to improve the energy efficiency of buildings.

Architectural Education

Architectural education is a crucial aspect of preparing future architects for their professional careers. Curtis and Shiffer (2015) defined architectural education as a process that develops a range of skills and knowledge that enables students to design buildings that are functional, safe, sustainable, and aesthetically pleasing. Architectural education has evolved over the years, and contemporary architecture schools offer a diverse range of programs and courses that cater to the evolving needs of the profession. Studies have shown that architectural education has a significant impact on the perception and practices of architectural students. Elshater and Abotaleb (2021) found that architectural students' perception of sustainable design significantly improved after they completed a course on sustainable architecture. The study concluded

that since architectural education plays a vital role in shaping the perception of students towards sustainable design, therefore, academic programs should be designed to promote sustainable architecture (Elshater & Abotaleb, 2021).

Furthermore, architectural education has been found to have a positive impact on the overall design skills of students. In a study by Ahmed and Alshawi (2018), it was observed that architectural education helped students develop problem-solving and critical thinking skills, which are essential in the profession. The study also highlighted the need for architectural education to provide practical training that equips students with the necessary skills to tackle real-world design challenges.

Architectural Sustainable Design

Sustainable design is an essential aspect of modern architectural practice that aimed at minimizing the environmental impact of buildings and promote the efficient use of natural resources (Onamade, Asaju and Adetona, 2022). Mahdavi and Pakzad (2012) concluded that Sustainable design is an approach to architecture that create buildings that are healthy,resource-efficient, and environmentally responsible. This conclusion was supported by Onamade, Asaju, and Daramola, (2022) viewing sustainable design as healthy and resource efficient buildings. Other studies have shown that sustainable design has several benefits, including energy efficiency, reduced carbon footprint, and improved indoor air quality. In their study, Shabha and Ali (2019) found that sustainable design practices significantly improve the energy efficiency of buildings. The study concluded that the use of sustainable design principles and practices can reduce the energy consumption of buildings by up to 50%, resulting in significant cost savings and environmental benefits (Shabha and Ali 2019).

Furthermore, sustainable design has been found to have a positive impact on the health and well-being of building occupants. According to a study by Upadhyay and Ahmad (2020), sustainable design principles, such as the use of natural light and ventilation (Asaju, Onamade and Daramola, 2022), can significantly improve indoor air quality and create healthier living spaces (Alagbe, et al., 2023). The study also highlighted the need for sustainable design to be incorporated into

architectural education to promote the use of sustainable design practices in future buildings.

Conclusively, sustainable design is an essential aspect of modern architectural practice. It aims to minimize the environmental impact of buildings and promote the efficient use of natural resources. Sustainable design has several benefits, including energy efficiency, reduced carbon footprint, and improved indoor air quality. Therefore, incorporating sustainable design principles into architectural education is necessary to promote the use of sustainable design practices in future buildings.

Energy efficiency in Sustainable design

Energy efficiency is a critical aspect of sustainable design and has become an increasingly important consideration in architectural practice(Onamade, Asaju, & Adewumi, 2023). It refers to the efficient use of energy in buildings to minimize energy consumption and reduce the carbon footprint. According to Mahlia et al. (2014), "Energy efficiency is a key strategy for reducing greenhouse gas emissions and mitigating climate change. Studies have demonstrated that energy efficiency has a number of advantages, including decreased energy use, financial savings, and increased indoor comfort. Compared to conventional structures, *Liu et al.*, (2021) study indicated that energy-efficient buildings can cut their energy use by up to 50%. The study concluded that energy-efficient buildings can significantly reduce the energy consumption of buildings and contribute to the achievement of global energy and climate goals.Furthermore, energy efficiency has been found to have a positive impact on indoor comfort and health. According to a study by *Dong et al. (2019)*, energy-efficient buildings can significantly improve indoor air quality and thermal comfort. The study also highlighted the need for architects to incorporate energy-efficient design principles into their practice to promote the efficient use of energy in buildings.

In conclusion, energy efficiency is a critical aspect of sustainable design and has several benefits, including reduced energy consumption, cost savings, and improved indoor comfort. Energy-efficient buildings can contribute to the achievement of global energy and climate goals while promoting the health and well-being of building occupants. Therefore, architects should incorporate energy-efficient design

principles into their practice to promote the efficient use of energy in buildings.

Perception Assessment of Students

Perception assessment is an important tool for evaluating how individuals perceive a particular topic or issue. It is often used in research studies to understand people's attitudes, beliefs, and opinions on a specific subject. In the context of architectural education and sustainable design, perception assessment can help evaluate students' understanding and awareness of sustainable design principles.

According to *Alzoubi et al. (2021),* perception assessment can be used to evaluate students' knowledge and awareness of sustainable design principles. The study found that "perception assessment is an effective tool for evaluating students' understanding of sustainable design principles and can help identify areas where further education and training are needed" (*Alzoubi et al., 2021*, p. 1). In another study, Yuniarti et al. (2019) used perception assessment to evaluate students' attitudes towards sustainable design. The study found that "perception assessment can be used to evaluate students' attitudes towards sustainable design and identify areas where further education and training are needed to promote the use of sustainable design practices in future buildings" (*Yuniarti et al.*, 2019, p. 1).

Perception assessment can also be used to evaluate the effectiveness of educational interventions aimed at promoting sustainable design practices. In a study by Jalali and Mahmoodi (2018), perception assessment was used to evaluate the impact of an educational intervention on students' knowledge and understanding of sustainable design principles. The study found that "perception assessment can be used to evaluate the effectiveness of educational interventions and identify areas where further education and training are needed to promote the use of sustainable design practices in future buildings" (Jalali & Mahmoodi, 2018, p. 1).

In conclusion, perception assessment is an important tool for evaluating students' knowledge and understanding of sustainable design principles. It can help identify areas where further education and training are needed to promote the use of sustainable design practices in future buildings. Therefore, perception assessment should be incorporated into

architectural education to evaluate students' attitudes, beliefs, and opinions on sustainable design and promote the efficient use of energy in buildings.

Architectural Students in Tertiary Institution

Architectural education is a critical component of developing the next generation of architects who will shape our built environment (Adewumi, Onamade & Asaju, 2023). Architectural students in tertiary institutions play a vital role in this process. Below are some examples of how architectural students in tertiary institutions have been discussed in the literature.In a study by Akande and Fagbenle (2019), the performance of architectural students in Nigeria was assessed through a survey of their academic grades. The study found that "architectural students in tertiary institutions in Nigeria performed better in design and theory courses than in technical and management courses, indicating a need to enhance the technical and management curricula in architectural education in Nigeria" (Akande and Fagbenle, 2019, p. 1).

In another study by Aziz et al. (2018), the perception of architectural students towards the use of Building Information Modelling (BIM) technology in their design studios was investigated. The study found that "architectural students in tertiary institutions are interested in using BIM technology, but lacked the necessary skills and knowledge to implement it effectively in their design projects" (Aziz et al., 2018, p. 1). Also, Gür et al. (2021) explored the impact of COVID-19 on architectural education and the learning experiences of architectural students in Turkey. The study found that "the pandemic has highlighted the need for tertiary institutions to adapt their teaching methods and provide more online resources to support architectural students in their learning" (Gür et al., 2021, p. 1). He concluded that, architectural students in tertiary institutions are important stakeholders in the development of the built environment. Their academic performance, perceptions, and learning experiences can provide valuable insights into the strengths and weaknesses of architectural education programme. The COVID-19 pandemic has highlighted the need for tertiary institutions to adapt to changing circumstances and provide students with the necessary resources to succeed in their education and future careers as architects.

Building Performance

Building performance refers to the effectiveness of a building in meeting the needs of its occupants while minimizing its environmental impact. The environmental impact of buildings includes factors such as energy consumption, water use, and greenhouse gas emissions(Asaju, Onamade, Chukwuka& Odefadehan, 2024). The following are some examples of how building performance and environmental impact have been discussed in the literatures.

In a study by Ferreira and Bragança (2020), building performance was assessed using a multidimensional framework that considered energy efficiency, indoor environmental quality, and environmental impact. The study found that "a comprehensive approach to building performance that includes environmental impact can help optimize the performance of buildings in terms of energy efficiency and indoor environmental quality, while minimizing their impact on the environment" (Ferreira and Bragança, 2020, p. 1). Another study by Leaman and Bordass (2013) emphasized the importance of post-occupancy evaluation (POE) in assessing building performance and environmental impact. The study found that "POE can help identify areas where building performance falls short of expectations and can provide valuable feedback for improving the environmental impact of buildings" (Leaman and Bordass, 2013, p. 1).

In a study by Alarcon et al. (2020), the environmental impact of buildings was assessed using Life Cycle Assessment (LCA) methodology. The study found that "LCA can provide a comprehensive and quantitative assessment of the environmental impact of buildings and can be used to identify areas where improvements can be made to reduce their environmental impact" (Alarcon et al., 2020, p. 1). In conclusion, building performance and environmental impact are closely related and should be considered together in the design, construction, and operation of buildings. A comprehensive approach to building performance that considers energy efficiency, indoor environmental quality, and environmental impact can help optimise the performance of buildings while minimizing their impact on the environment. Post-occupancy evaluation and life cycle assessment are important tools for assessing building performance and environmental impact and identifying areas where improvements can be made.

Materials and Methods

A cross-sectional survey approach was adopted in this study, well-structured questionnaire randomly distributed among108 architectural students in Caleb University, Lagos. The returned data were analysed using Statistical Package for Social Science (SPSS). With descriptive statistics and frequency distribution and relationship between the variables evaluated by correlation and analysis of variance were conducted (ANOVA).

Results

This study was set out on specific objectives in understanding the architectural student perception on energy efficiency in architectural designs. Table 1 shows the demographic characteristics of the respondents with male accounting for 71.3% of the population and female 26.9% and 1.9% was missing in the result. The age range of the respondents with highest percentage is 16-20years with 42.6% followed by 21-25years with 31.5%, also 31years and above amounted to 19.4%. Finally, age 26-30years amounted to 6.5%. 65.7% of the respondents holds B.Sc. degree, 9.3% holds M.Sc. degree and 4.6% had professional qualifications, while 20.4% did not respond with their degree.

Table 1: Demographic characteristics of the respondents

Gender	**Frequency**	**Percent**
Male	77	71.3
Female	29	26.9
Missing System	2	1.9
Total	108	100.0
Age		
16-20 years	46	42.6
21-25 years	34	31.5
26-30 years	7	6.5
31 years above	21	19.4
Total	108	100.0
Degree		
B.Sc.	71	65.7
M.Sc.	10	9.3
Professional qualification	5	4.6
Total	86	79.6
Missing System	22	20.4

Source: *Authors field work*

Assessing the level of awareness of architectural students incorporating energy efficiency into architectural designs through active design strategies than passive design strategies. Table 2 showed that 33.4% disagreed that active and passive design could not be incorporated into architectural design while 30.5% agreed that it could be incorporated into architectural design whereas 35.2% neither agreed nor disagreed. Therefore, the level of respondent's awareness is 30.5% while 69.5% are not aware. This is graphically shown in Fig.1.

Table 2: Awareness of incorporating active and passive design strategies

	Frequency	Percent	Valid Percent
Strongly Disagree	7	6.5	6.5
Disagree	29	26.9	27.1
Neither agree nor disagree	38	35.2	35.5
Agree	25	23.1	23.4
Strongly Agree	8	7.4	7.5
Total	107	99.1	100.0
System	1	.9	
Total	108	100.0	

Source: *Authors field work 2023*

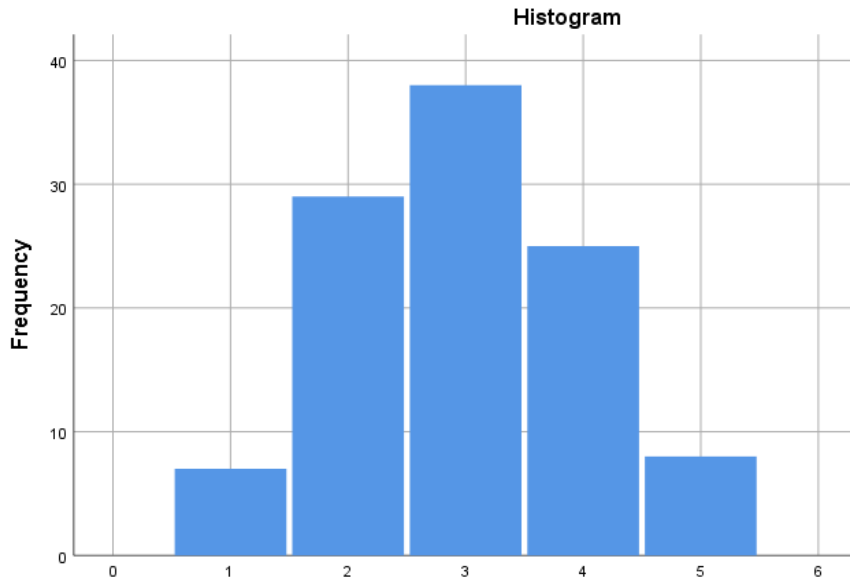

Figure 1: Awareness of incorporating active and passive design strategies.

From the third objective, in seeking to assess the knowledge of how energy sustainability be achieved. The students were asked whether the energy sustainability cannot be incorporated into architectural design

through energy efficiency nor renewable energy. The result showed that 69.4% disagreed, while 14.8% agreed and 14.8% neither agreed nor disagreed. Therefore, the result showed that the students are knowledgeable about achieving energy sustainability through architectural design.

Table 3:Students' knowledge on energy sustainability

	Frequency	Percent
Strongly Disagree	21	19.4
Disagree	54	50.0
Neither agree nor disagree	16	14.8
Agree	15	13.9
Strongly Agree	1	.9
System	1	.9
Total	108	100.0

Source: *Authors field work 2023*

Figure 2 shows the graphical representation of the respondents with strongly agreed and agree accounted for the greater percentage with 75 respondents showing that they are knowledgeable in the incorporation of energy sustainability into architectural design.

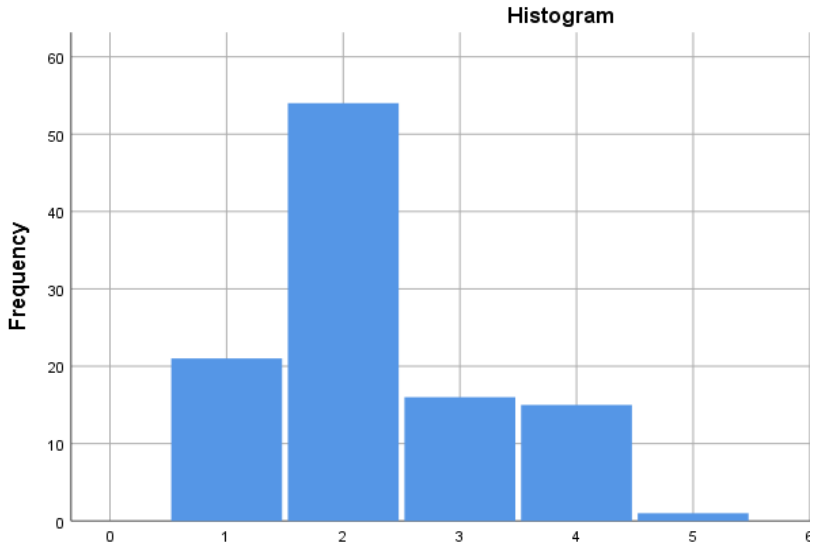

Figure 2: Knowledge of incorporating Energy Sustainability architectural design.

The last objective aimed at examining the relationship between student's awareness of incorporating active and passive design strategies and students' knowledge on energy sustainability into architectural designs. From Table 4, there is a significant relationship between awareness of energy sustainability into architectural drawing and the knowledge of energy sustainability in architectural drawing. It is significant at 10% and the correlation is at 30%.

Table 4: Relationship between awareness of incorporating active and passive design strategies and Students' knowledge on energy sustainability

Correlations

		Awareness of Energy Sustainability into architectural design.	Knowledge of Energy Sustainability in Arch design
Awareness of Energy Sustainability into architectural design.	Pearson Correlation	1	
	Sig. (2-tailed)		
	N	107	
Knowledge of Energy Sustainability in Arch design	Pearson Correlation	.307**	1
	Sig. (2-tailed)	.001	
	N	107	107

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

Further analysis of variance was tested at significant difference of .001

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
	Regression	10.720	1	10.720	10.902	.001[b]
	Residual	103.243	105	.983		
	Total	113.963	106			

a. **Dependent Variable**: Energy Sustainability cannot be best incorporated into architectural design through active design strategies than passive design strategies.

b. **Predictors:** (Constant), Energy Sustainability cannot be incorporated into architectural design through energy-efficient building nor through renewable energy systems.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig.
	(Constant)	2.236	.245		9.115	.000
	Knowledge of Energy Sustainability in Arch design	.330	.100	.307	3.302	.001

a. **Dependent Variable**: 9. Energy Sustainability cannot be best incorporated into architectural design through active design strategies than passive design strategies.

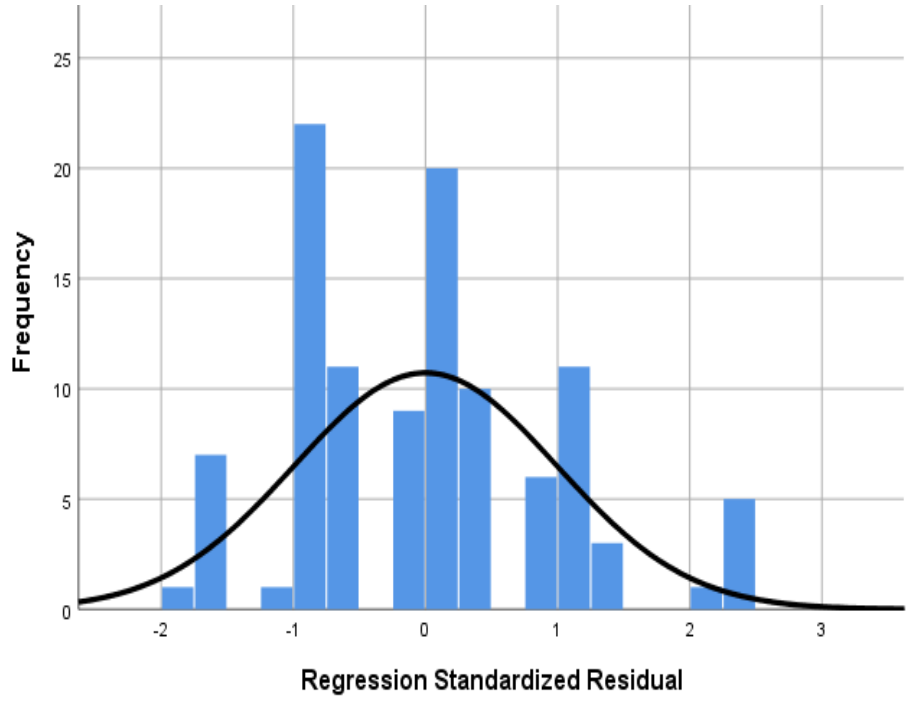

Figure 3: Relationship between awareness of incorporating active and passive design strategies and Students' knowledge on energy sustainability.

Conclusion and Recommendation

This study concluded based on the set-out objectives,firstly, the level of respondent's awareness of architectural students incorporating energy efficiency into architectural designs through active design strategies than passive design strategies is very low.

Secondly, the students are knowledgeable about achieving energy sustainability through architectural design. Finally, since there is a significant relationship between awareness and knowledge of achieving energy sustainability in architectural design efforts should be made to maintained and sustain both in the training of architectural students. This study therefore recommends that student awareness should be intensified both in their training and in the curriculum.

References

Adewumi, Bamidele J,Onamade, Akintunde O.,Asaju, Opeyemi A. &Adegbile, M.. B.O. (2023). 'Impact of architectural education on energy sustainability in selected schools of architecture in lagos megacity', *Caleb International Journal of Development Studies*, 6(2), pp. 209–218.

Adewumi, Bamidele J.; Onamade,Akintunde O.& Asaju, O.A. (2023). Impact of Circular Economy on Sustainable Development in Lagos Mega City in Ope Oredin and Oyedokun(eds). 'Lead City University Postgraduate Multidisciplinary Serial, (Series 3) in *Multidisciplinary conference,* pp. 258–271.

Ahmed, V.& Alshawi, M.(2018). The role of architectural education in developing critical thinking and problem-solving skills among architecture students. *Journal of Educational and Social Research, 8(2), 1-6.*

Alagbe, O.,Onamade, A.O. & Asaju, O. (2023). Investigating construction and demolition waste management practices among building industry professionals in Lagos, Nigeria. In: Aigbavboa, C., Thwala, W., & Aghimien, D. (eds.) Towards a sustainable construction industry:*The role of innovation and digitalisation. CIDB 2022. Springer, Cham. https://doi.org/ 10.1007/978-3-031-22434-8_45*

Alarcon, L. F., Montenegro, G., Martinez, D., & Maturana, S. (2020). Life cycle assessment of an office building in Chile: *Environmental*

impacts of materials, energy use and transport. Journal of Cleaner Production, 271, 12-26.

Alzoubi, F. A., Ghabayen, S. M., Al-Qudah, A. T., & Al-Mousa, M. R. (2021). Perception assessment of students' knowledge and awareness of sustainable design principles: A case study of architectural engineering students. *Journal of Cleaner Production, 309, 127166.*

Asaju, O.A., Onamade, A.O. and Daramola, S.A. (2022) 'Post occupancy evaluation of federal university administrative', *Global Scientic Journal*, 10(11), pp. 2764–2778.

Asaju O. A., Onamade A.O., Chukwuka O.P.& Odefadehan C.T.(2024) 'IEQ of studio environment on academic performance of architecture studio.*Middle Eastern Journal in Education and Social Sciences*, 5(1), pp. 1–7. Available at: https://doi.org/10.47631/mejress.v5i1.672.

Asaju Opeyemi Adeola, Onamade Akintunde Olaniyi, Chukwuka Obianuju P, Odefadehan Christian Tayo (2024) 'IEQ of studio environment on academic performance of architecture studio *Middle Eastern Journal of Researchin Education and Social Sciences*, 5(1), pp. 1–7. Available at: https://doi.org/10.47631/ mejress.v5i1.672.

Curtis, D. & Shiffer, M. (2015). Architecture education today. *The Journal of Architecture, 20(1), 1-11.*

Dong, B., Zhao, X., Wang, L., & Li, B. (2019). Evaluation of the indoor thermal comfort and air quality of energy-efficient buildings in winter. *Energy Procedia, 158, 3904-3911.*

Elshater, A. & Abotaleb, A. (2021). Investigating the effectiveness of a sustainable architecture course on architectural students' perception of sustainable design,*Sustainability, 13(4), 1874.*

Ferreira, A. M. & Bragança, L. (2020). Multidimensional building performance assessment framework*, Energy and Buildings, 225, 110312.*

International Energy Agency (IEA)(2020). Energy efficiency 2020.

Retrieved from https://www.iea.org/reports/energy-efficiency-2020

Jalali, M. S. & Mahmoodi, M. (2018). The impact of educational intervention on the knowledge and perception of sustainable

design among architecture students. *Sustainable Cities and Society, 40, 394-403.*

Kamaruzzaman, S. N., Egbu, C. O., Zawawi, E. M. A. & Abdul-Malek, Z. (2018). The role of architectural education in promoting sustainable built environment. *Journal of Engineering, Design and Technology*, 16(2), 239-251. doi: 10.1108/JEDT-09-2017-0085

Leaman, A. &Bordass, B. (2013). Briefing: Building evaluation. *Building Research & Information, 41(3), 237-239.*

Liu, Z., Zhang, Y., Zhao, W. & Liu, Y. (2021). Energy-saving potential analysis of an energy-efficient building based on energy consumption monitoring data. *Building and Environment, 197, 107590.*

Mahdavi, A. & Pakzad, S. N. (2012). Sustainable design: A critical analysis. *International Journal of Architectural Engineering and Urban Planning, 22(2), 1-10.*

Mahlia, T. M. I., Saidur, R.& Memon, L. A. (2014). A review on energy scenario and sustainable energy in Malaysia. *Renewable and Sustainable Energy Reviews, 32, 318-334.*

Onamade, Akintunde Olaniyi, Asaju, Opeyemi Adeola and Adewumi, B.J. (2023) 'Urban mining towards sustainability in Lagos Mega city,in Ope Oredin and Oyedokun(eds).163–174. Available at: https://doi.org/10.1002/cind.827_6.x.

Onamade, A.O., Asaju, O.A.& Adetona, O. (2022) 'Building Industry Professional Attitude Towards Construction And Demolition Waste Hazards In Lagos', 16(11), pp. 26–31. Available at: https://doi.org/10.9790/2402-1611022631.

Onamade, A.O., Asaju, O.A. and Daramola, S.A. (2022) 'Building Industry Professionals' Attitude Towards Construction and Demolition Waste Disposal on Building Projects in Lagos Metropolis, Nigeria 7(November), pp. 1–9. Available at: http://journals.rcmss.com/index.php/jggsda.

Shabha, G., & Ali, M. (2019). The impact of sustainable design practices on energy consumption in buildings. *International Journal of Energy Economics and Policy, 9(4), 199-205.*

Tavsanoglu, G. G., Inanici, M. N. & Arslan, H. (2016). Evaluation of architectural education on sustainable design principles: A case study in Turkey. *Journal of cleaner production,* 111, 358-369. doi: 10.1016/j.jclepro.2015.09.074

Upadhyay, A. & Ahmad, S. (2020). The impact of sustainable design principles on indoor air quality of residential buildings. *Journal of Sustainable Development of Energy, Water and Environment Systems, 8(1), 64-74.*

Yuniarti, N.L.P., Rahayu, N. P.&Manuaba, I. B. A. (2019). Perception of sustainable design among architecture students in Bali. *Proceedings of the International Conference on Education, Social Sciences and Humanities, 6(1), 51-57*