ENVIRONMENTAL IMPACT ON ENERGY EFFICIENCY OF ARCHITECTURAL STUDIOS IN SELECTED TERTIARY INSTITUTIONS IN LAGOS MEGA-CITY, NIGERIA

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A B S T R A C T

The core developmental value system of the 21st century is sustainability, which has been approached from multiple perspectives, including energy efficiency. Indoor environmental quality, comfort and sustainability in indoor spaces are key factors to be considered. This study aims to evaluate the Indoor Environmental Quality (IEQ) as a design parameter for measuring energy efficiency, the Impact of Energy efficiency on the IEQ of Architectural studios as well as the relationship between indoor environmental quality as a design parameter for measuring energy efficiency and impact of energy efficiency on IEQ of Architectural Studios in selected tertiary institutions in Lagos Mega City. The key objectives were to assess indoor environmental quality as a design parameter for measuring energy efficiency, the Impact of Energy efficiency on IEQ of Architectural studios and examine the relationship between indoor environmental quality as a design parameter for measuring energy efficiency and the impact of energy efficiency on IEQ of Architectural Studios. A quantitative data collection method of the structured survey with both closed- and open-ended questions was designed, data were collected from 108 students in the selected tertiary institutions on the IEQ parameters and energy consumption of their architectural studios. Data were analysed using the Statistical Package for the Social Sciences (SPSS). 89 respondents agreed that energy efficiency impacts the architectural studios' indoor environmental quality, accounting for 82.4%. In comparison, the remaining 19 respondents (7.6%) disagreed on the energy efficiency impact on the architectural studios. Also, a positive relationship exists between IEQ as a design parameter for energy efficiency and the effect of energy efficiency on the IEQ of architectural studios. Therefore, the study recommends that architectural studios be designed to maximise energy efficiency principles.

1. Introduction

The constant change in climatic conditions calls for a holistic approach to energy usage. Not only is the climate changing, but it is also posing a threat to comfort in indoor spaces and translating to an increase in energy usage and bills. The core developmental value system of the 21st century is sustainability, which has been approached from multiple perspectives, including energy efficiency. Sustainable housing is environmentally-conscious housing that tries to minimise the negative environmental impact of buildings by boosting energy efficiency (Ayobami et al., 2018). Globally, the building sector consumes 42 percent more electricity than any other (Adewumi et al., 2023). It's no surprise given that we spend more than 90% of our time indoors (Lemaire, 2008). Due to architectural studios' peculiarity, students tend to work inside round the clock as it has turned into their second home. Among the several factors that would afford them a conducive and comfortable experience in architectural studios is energy. where several hours are used to brainstorm solutions to design briefs. Due to the low energy supply, students often seek and utilise alternative artificial energy(Hasan et al., 2017). Despite being the brains behind design themselves within the confines of their studios, most of these spaces do not apply a holistic design approach (Adewumi et al., 2023). According to Mitterer et al., (2012), holistic building design is difficult because climatic boundary conditions greatly influence both comfort and

energy efficiency requirements. To this end, this study assesses the indoor environmental quality as a design parameter for measuring energy efficiency, the Impact of Energy efficiency on IEQ of Architectural studies and examines the relationship between indoor environmental quality as a design parameter for measuring energy efficiency and the impact of energy efficiency on IEQ of Architectural Studios.

2. Literature review

Energy efficiency in architectural studio

The use of less energy to produce the same energy services or outputs is referred to as energy efficiency. It is a significant idea in the context of environmental conservation and sustainability (Aghimien et al., 2016). Improving energy efficiency is critical for combating climate change, lowering energy prices, and ensuring the long-term viability of our energy systems (Hoyo-Montaño et al., 2019). In today's world, the building can not only consume but also generate its energy (Samuratova et al., 2019). However, an architectural studio because of its peculiarly requires good lighting quality and a thermal (energy) environment for work to be done accurately and effectively.

It entails a combination of technological improvements, legislative changes, and individual activities to reach a more sustainable and energy-efficient future. Improving energy efficiency can have several advantages. Understanding human thermal and visual comfort is important because the majority of energy utilised in a structure is to satisfy these two human demands (Delight et al., 2017) in an architectural studio. Most conventional literature and existing studies, however, remain more focused on energy consumption rather than occupant satisfaction, ignoring the reality that human behaviour in avoiding discomfort might be directly linked to end-use energy (Delight et al., 2017).

Building Design and Orientation

One of the primary goals of building design and control is to provide occupants with a comfortable building environment. Building energy efficiency is a hot topic that has the potential to save energy and money while also improving overall sustainability (Xiong & Dissertation, 2019). Having a climate-specific design increases energy efficiency and provides a good indoor environment for the occupants. The design and construction of well-insulated building envelopes with high-quality windows, doors, and insulation materials that minimize heat gain or loss and reduce the energy required for heating or cooling is critical. Nag (2019) opined that mechanical ventilation and HVAC systems are overly reliant on modern building envelopes. Daylighting, energy-efficient lighting, efficient HVAC systems, thermal comfort, and environmentally friendly materials are other areas of consideration for energy efficiency in architectural studios.

Energy efficiency is a vital component of sustainable design practices in architecture studios. It entails making informed decisions about building design, materials, and operations to reduce energy use while yet delivering a comfortable and effective workspace. The use of passive design principles that make use of the local environment to lessen the need for mechanical heating or cooling is critical (Boake, n.d.). This can involve maximizing natural ventilation, optimizing building orientation, and utilizing thermal mass (General Overview, 2010).

Indoor environmental Quality and energy efficiency

Okanya et al. (2021) describe indoor environmental quality as the circumstances inside the structure, which include air quality, access to daylight and vistas, pleasant acoustics, and occupant control over lighting and thermal comfort. Balancing energy efficiency with Indoor Environmental Quality (IEQ) performance has become a conventional tradeoff in sustainable building design (El Asmar et al., 2014). Many criteria for acceptable ranges and threshold values for indoor environmental quality indicators have been devised to protect the people, including measures for energy efficiency, thermal comfort, and human health (Asaju et al., 2024). Energy efficiency and improvements to indoor environmental quality are linked, but both can be accomplished at the same time (Laskari et al., 2017).

Indoor environmental quality parameters have ways of influencing energy efficiency with greater attention on thermal quality which has more connection with heat release and key determinants in academic space (Lamberti et al., 2021). A comfortable and healthy lecture room is vital to the student's final output since the indoor environment influences the health, performance, and behaviour of occupants, and this is determined by the quality of the indoor environment quality (Asaju et al., 2022). Energy efficiency (EE), and indoor environmental quality (IEQ) are two out of the six major criteria used to certify green buildings. Others include water efficiency (WE), sustainable site management and planning (SM), material and resources (MR), and innovation (IN) are the acronyms for these concepts (Kasim et al., 2015).

Occupant Comfort and Satisfaction

The primary purpose of workspace construction is to provide a comfortable workplace that will maximize human productivity. Nguyen et al. (2018), in their work, expressed that, temperature, noise, and light are major predictors of occupant satisfaction, according to previous research. From an economic standpoint, the cost of energy savings or running costs is sometimes significantly lower than the cost of productivity loss (El-Salamouny et al., 2019). Thermal comfort, rather than low water supplies, maybe the limiting barrier to achieving high occupant satisfaction and reduced building energy demand in hot, arid climates with mainly cooling requirements, according to studies (Kalvelage et al.,

2014). Occupant satisfaction and comfort are critical features of building design and operation, and they play a substantial part in an architectural space's overall success and functionality (Kim et al., 2019). A rise in heat transfer through building materials has prompted a deeper look at lecture halls. Students devote a significant chunk of their days to learning (Boake et al., n.d.). The overall level of comfort or satisfaction in maintaining indoor environmental stability will depend grossly on the energy required to achieve (Adewumi et al., 2023). Therefore, this study will further assess indoor environmental quality as a design parameter for measuring energy efficiency, the Impact of Energy efficiency on IEQ of Architectural studios and examine the relationship between indoor environmental quality as a design parameter for measuring energy efficiency and the impact of energy efficiency on IEQ of Architectural Studios.

3. Methodology

A cross-sectional survey research method was used for the study,108 questionnaires were returned out of 120 randomly distributed. The questionnaire consists of 6 sections with 6 items with a Likert scale rating while one section contained 7 items of open-ended questions other sections were closed-ended questions with an overall reliability scale of .866 for a total of 30 items. The data collected were analyzed using Statistical Package for the Social Sciences (SPSS). Descriptive Statistics were used in describing data relating to demographic characteristics while correlation coefficient was used in finding the relationship between variables among the students of selected tertiary institutions in Lagos megacity collected Data.

4. Result in Findings

Table 1: Demographic characteristics of the respondents in the selected tertiary institution

Gender	Frequency	Percent (%)
Male	77	71.3
Female	29	26.9
Missing	2	1.8
Duration of study		
Less than a year	26	24.1
1-2 years	4	3.7
3-4 years	25	23.1
5 years above	53	49.1
Degree		
Undergraduate	22	20.4
BSc	71	65.7
MSc	10	9.3
Professional qualification	5	4.6

Table 1 shows the background information of respondents. The gender of the respondents indicates that 26.9% were females 71.3% were males while 1.8% were missing. This shows that there are more male respondents in the study than females. This is because architecture as a course is male dominated. Also, their duration of study reveals 24.1% with barely a year in the faculty, 3.7% between a year and two,

23.1% having three to four years and 49.1% have spent five years and above in the profession and having the highest number of 53 respondents. This allows for a fair knowledge of the environmental impact of energy efficiency having experienced it for more years. Looking at their qualification, 65.7% of them already had a BSc, 9.3% MSc and 4.6% with professional qualifications while 20.4% were Undergraduate.

Table 2: Impact of Energy efficiency on IEQ of Architectural studio

	Frequency	Percent
Disagree	3	2.8
Neither agree nor disagree	10	9.3
Agree	41	38.0
Strongly Agree	48	44.4
Missing response	6	5.6
Total	108	100.0

Source: Authors field work 2023

The second objective assesses the Impact of Energy efficiency on the IEQ of Architectural studios. From Table 2, 89 respondents agreed that energy efficiency impacts the indoor environmental quality of architectural studios which account to 82.4% while the remaining 10 respondents (9.3%) neither agreed nor disagreed,3 respondents disagreed (2.8%) on the energy efficiency impact on architectural studios while 6 responses were missing. Figure 2 shows the graphical representation of the result.

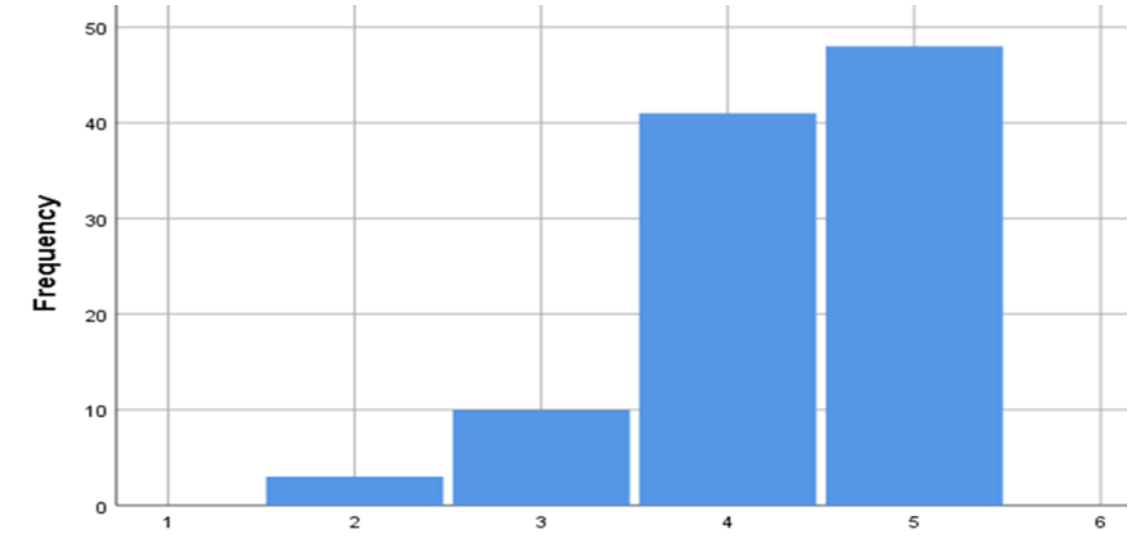

Figure 1: Impact of Energy efficiency on IEQ of Architectural studio

Also, the third objective examines the respondent's knowledge of indoor environmental quality as a design parameter for measuring energy efficiency and the result shows from Table 3 that 66.7% (72 respondents) agreed that IEQ is a design parameter for measuring energy efficiency while 33.3% (36 respondents) disagreed. Figure 3 also shows the graphical representation.

Table 3: Indoor Environmental Quality as a design parameter for measuring energy efficiency

	Frequency	Percent
Disagree	2	1.9
Neither agree nor disagree	26	24.1
Agree	43	39.8
Strongly Agree	29	26.9
Strongly Disagree	7	6.5
Missing Response	1	.9
Total	108	100.0

Source: Authors field work 2023

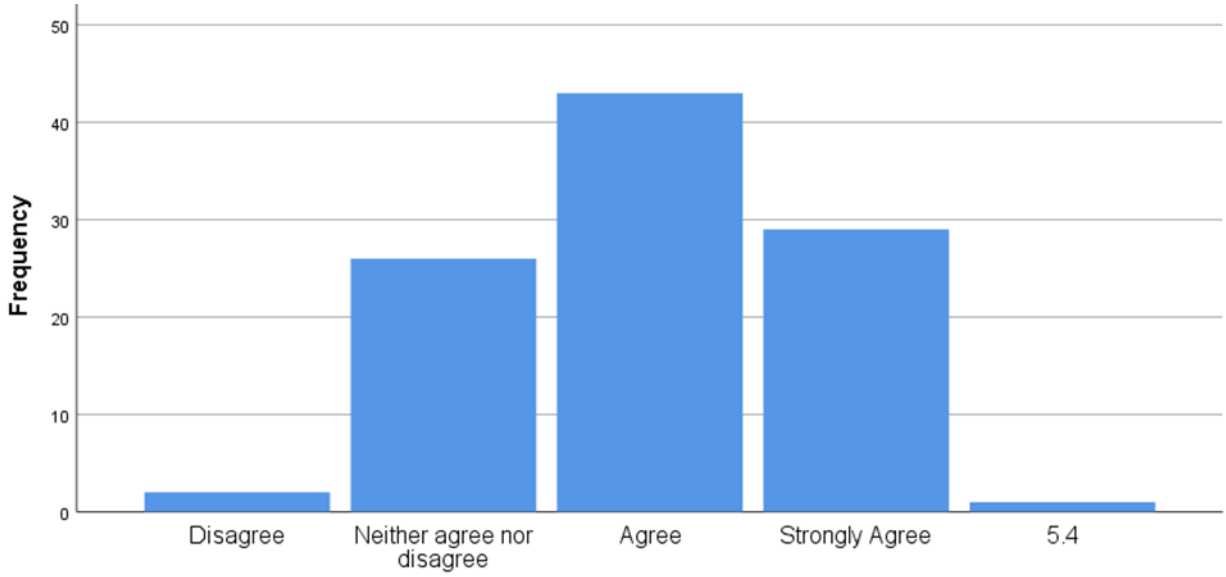

Figure 2: Indoor Environmental Quality as a design parameter for measuring energy efficiency

The final objective seeks to evaluate the relationship between Indoor Environmental Quality as a design parameter for measuring energy efficiency and the Impact of Energy efficiency on the IEQ of an Architectural studio. The result showed a significant difference on Pearson Correlation the correlation is significant at 0.01(1%) level (2-tailed) and the result showed .423 (42.3%).

Table 4: Relationship between Indoor Environmental Quality as a design parameter for measuring energy efficiency and the Impact of Energy efficiency on Architectural Studios

Correlations

		Indoor Environmental Quality as design parameter	Impact of Energy efficiency on IEQ of Architectural studio.
Indoor Environmental Quality as design parameter for measuring energy efficiency	Pearson Correlation	1	
	Sig. (2-tailed)		
	N	101	
Impact of Energy efficiency on IEQ of Architectural studio	Pearson Correlation	.423**	1
	Sig. (2-tailed)	.000	
	N	101	102

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

Table 4 shows correlations between indoor environmental quality (IEQ) being utilized as a design parameter to measure energy efficiency and the impact of energy efficiency on the IEQ of an architectural studio. Firstly, there's a significant positive correlation ($r = 0.423$, $p < 0.01$) between considering IEQ as a design parameter for measuring energy efficiency and the subsequent impact on the IEQ of an architectural studio. This suggests that when IEQ is considered during the design phase to enhance energy efficiency, it tends to have a positive effect on the overall IEQ of the architectural studio. This correlation underscores the importance of integrating IEQ considerations into energy-efficient design strategies, indicating that focusing on energy efficiency can lead to improvements in the indoor environment.

Conversely, the absence of a correlation coefficient and significance level for the IEQ parameter indicates that it is only examined as a predictor in this context, rather than being influenced by another factor within the study. This could imply that IEQ as a design parameter for measuring energy efficiency stands independently in its correlation with other variables, suggesting its importance in guiding energy-efficient architectural practices without being directly influenced by external factors examined in this study.

Summarily, table 4 suggests that there is a positive relationship between considering IEQ as a design parameter for energy efficiency and its impact on the IEQ of architectural studios. This underscores the interplay between energy efficiency considerations and the overall indoor environment, highlighting the importance of integrating IEQ considerations into architectural design practices aimed at enhancing energy efficiency.

5. Conclusion

This study concluded that energy efficiency impacts the indoor environmental quality of architectural studios and the level of IEQ determines the student's satisfaction level. Also, the respondents were knowledgeable of indoor environmental quality as a design parameter for measuring energy efficiency. Finally, there is a significant relationship between Indoor Environmental Quality as a design parameter for measuring energy efficiency and the Impact of Energy efficiency on the IEQ of Architectural studios. This study therefore recommends that architectural studios should be designed to maximise energy efficiency principles and encourage architecture students to incorporate energy efficiency principles into their design and practices beyond their studios.

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