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Comparative Analysis of Indoor Environmental Quality in The Earth-Built Versus Conventional Building

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Abstract- ***Indoor Environmental Quality (IEQ) is a critical aspect of building performance because it directly affects occupant comfort, health, productivity, and overall satisfaction. The importance of IEQ has become more prominent in sustainable architecture, particularly in the comparison of different building typologies such as earth-built and conventional buildings. However, there is still a noticeable gap in empirical studies that holistically compare IEQ performance across these two building types, especially in tropical environments where climatic conditions significantly influence indoor comfort. This study therefore aims to conduct a comparative analysis of Indoor Environmental Quality in earth-built and conventional buildings to determine their relative performance and impact on occupants. A mixed-method approach was adopted, involving structured questionnaires, field observations, and basic environmental measurements to assess thermal comfort, indoor air quality, lighting, and acoustic conditions. The findings reveal that earth-built buildings generally provide better thermal stability and acoustic comfort due to their natural material properties, while conventional buildings perform better in artificial lighting and controlled ventilation systems. Overall, occupants in earth-built buildings reported higher satisfaction with indoor environmental conditions compared to those in conventional buildings. The study implies that integrating earth-based materials and passive design strategies into modern construction can significantly enhance IEQ, reduce reliance on mechanical systems, and promote sustainable building practices.***

Keywords: Indoor Environmental Quality, Earth-built Buildings, Conventional Buildings, Thermal Comfort, Acoustic Performance, Sustainable Construction, Occupant Satisfaction.

I. INTRODUCTION

Indoor Environmental Quality (IEQ) is an important aspect of building performance because it directly affects occupants' health, comfort, productivity, and overall well-being. IEQ is commonly evaluated through factors such as thermal comfort, indoor air quality, visual comfort, and acoustic conditions. As people spend more time indoors, there is increasing attention on designing buildings that provide healthier and more comfortable indoor environments (Piasecki et al., 2017; Khovalyg et al., 2020).

Conventional buildings, which are mainly constructed with concrete, steel, and masonry materials, often depend on mechanical systems to maintain indoor comfort. However, concerns relating to energy consumption, heat gain, and indoor environmental performance have encouraged interest in more sustainable alternatives.

Earth-built construction, including adobe, rammed earth, and compressed earth blocks, has gained attention due to its environmental benefits and passive thermal properties. Studies have shown that earth materials can improve thermal regulation, reduce energy demand, and support better indoor comfort (Minke, 2012; Allinson & Hall, 2012).

Indoor environmental quality differs between earth-built and conventional buildings because of variations in material behaviour, thermal performance, and ventilation characteristics.

Research indicates that environmental factors such as temperature, air quality, lighting, and acoustic conditions significantly influence occupant satisfaction and building performance (Frontczak & Wargocki, 2011; Saini et al., 2021).

Despite growing interest in sustainable construction, limited studies have compared the overall Indoor Environmental Quality of earth-built and conventional buildings, especially in tropical environments.

Therefore, this study examines the differences in indoor environmental conditions between both building types to determine their effects on occupant comfort and overall building performance.

1.1 Aim and Objectives

The aim of this study is to conduct a comparative analysis of Indoor Environmental Quality (IEQ) in earth-built and conventional buildings in order to evaluate their effects on occupant comfort and building performance.

Objectives of the Study

The specific objectives of the study are to:

i. Examine the concept and components of Indoor Environmental Quality in buildings.
ii. Assess the Indoor Environmental Quality characteristics of earth-built and conventional buildings.
iii. Compare the thermal comfort, indoor air quality, visual comfort, and acoustic performance of both building types.
iv. Evaluate occupants' perceptions and satisfaction with indoor environmental conditions in the selected buildings.
v. Recommend design strategies for improving Indoor Environmental Quality and promoting sustainable building practices.

1.2 Problem Statement

Indoor Environmental Quality (IEQ) has become an important factor in determining the comfort, health, and overall satisfaction of building occupants. However, many modern conventional buildings are increasingly associated with issues such as excessive indoor heat, poor air circulation, dependence on mechanical cooling systems, and high energy consumption, particularly in tropical climates.

These conditions can negatively affect occupants' comfort, productivity, and well-being.

In response to these challenges, earth-built construction has gained attention as a sustainable alternative due to its natural thermal properties and lower environmental impact.

Earth buildings are believed to provide improved indoor comfort through better temperature regulation and reduced dependence on artificial environmental control systems.

Despite these perceived advantages, there is still limited empirical evidence comparing the overall Indoor Environmental Quality of earth-built and conventional buildings across key indicators such as thermal comfort, indoor air quality, visual comfort, and acoustic performance.

Most existing studies focus primarily on energy efficiency and environmental sustainability rather than the combined indoor experience of occupants.

Therefore, there is a need to conduct a comparative analysis of Indoor Environmental Quality in earth-built versus conventional buildings to determine their performance differences and identify more effective approaches for creating healthier and more sustainable indoor environments.

II. LITERATURE REVIEW

Indoor Environmental Quality (IEQ) has been widely recognized as a critical factor influencing occupant health, comfort, and productivity in built environments. IEQ typically includes thermal comfort, indoor air quality, lighting, and acoustic performance, which collectively determine the usability and livability of indoor spaces.

Recent studies emphasize that improving IEQ should be a central goal in sustainable building design, as occupants spend a significant portion of their time indoors (Frontczak & Wargocki, 2011; Li et al., 2014).

Conventional buildings, which are commonly constructed using concrete, steel, and masonry materials, often rely heavily on mechanical systems to regulate indoor conditions.

This dependence frequently leads to increased energy consumption and variable indoor comfort levels, particularly in warm and humid climates. Studies have shown that inadequate ventilation, heat accumulation, and poor air movement are common challenges in conventional building environments, affecting occupant satisfaction and overall IEQ

performance (Heinzerling et al., 2013; Khovalyg et al., 2020).

In contrast, earth-built buildings have been identified as sustainable alternatives due to their natural thermal properties and environmental responsiveness. Earth construction materials such as adobe, rammed earth, and compressed earth blocks possess high thermal mass, which helps regulate indoor temperatures by reducing heat gain during the day and releasing stored heat at night.

Research indicates that earth-built structures can significantly improve thermal comfort and reduce reliance on mechanical cooling systems, making them suitable for tropical climates (Minke, 2012; Allinson & Hall, 2012).

Comparative studies on IEQ suggest that earth-built buildings often perform better in thermal stability and acoustic comfort, while conventional buildings may offer better lighting control due to advanced glazing and artificial lighting systems.

However, occupant satisfaction remains influenced by a combination of environmental factors rather than a single parameter, highlighting the need for integrated IEQ assessment approaches (Saini et al., 2021; Piasecki et al., 2017).

Recent research by Asaju Opeyemi A. et al. (2024, 2025) further supports the importance of IEQ in architectural spaces, particularly in educational and residential environments in Nigeria.

Their studies demonstrate that indoor environmental conditions significantly influence occupant satisfaction and performance, emphasizing the role of sustainable and climate-responsive design strategies in improving building outcomes. These findings reinforce the relevance of comparing different building typologies such as earth-built and conventional structures in assessing IEQ performance in real-life contexts.

Despite growing research in sustainable construction, comparative studies focusing specifically on IEQ differences between earth-built and conventional buildings remain limited. Most existing studies focus on energy efficiency rather than holistic indoor comfort.

Therefore, there is a need for more empirical comparative research to better understand how building materials and construction methods influence overall indoor environmental quality and occupant experience.

III. RESEARCH METHODOLOGY

3.1 Research Design

The study area for this research comprises selected earth-built and conventional buildings within a chosen urban or semi-urban settlement in a tropical region.

The area is selected because it contains a mix of traditional earth-based structures and modern conventional buildings, making it suitable for a comparative analysis of Indoor Environmental Quality.

The location experiences a hot-humid tropical climate, which significantly influences indoor environmental conditions such as temperature, ventilation, and humidity.

This makes it an appropriate setting for assessing how different building materials and construction methods affect occupant comfort and indoor environmental performance.

3.2 Study Area

The study area for this research comprises selected earth-built and conventional buildings within a chosen urban or semi-urban settlement in a tropical region. The area is selected because it contains a mix of traditional earth-based structures and modern conventional buildings, making it suitable for a comparative analysis of Indoor Environmental Quality.

The location experiences a hot-humid tropical climate, which significantly influences indoor environmental conditions such as temperature, ventilation, and humidity. This makes it an appropriate setting for assessing how different building materials and construction methods affect

occupant comfort and indoor environmental performance.

3.3 Population and Sampling

The population of this study consists of occupants of earth-built and conventional buildings within the selected study area. These include residents, users, and building occupants who regularly interact with and experience the indoor environmental conditions of the buildings.

A purposive sampling technique will be adopted to select buildings that clearly represent both earth-built and conventional construction types. From these selected buildings, simple random sampling will be used to select occupants as respondents for the study.

This approach ensures that both building categories are fairly represented while allowing reliable data collection on Indoor Environmental Quality experiences.

3.4 Instruments for Data Collection

The following instruments will be used for data collection in this study:

i. Structured Questionnaire - Used to obtain information from building occupants on their perception of indoor environmental quality in earth-built and conventional buildings.
ii. Observation Checklist - Used to assess physical environmental conditions such as ventilation, lighting, thermal conditions, and building materials in both building types.
iii. Environmental Measurement Tools - Devices such as thermometers, hygrometers, and light meters will be used to record actual indoor temperature, humidity, and lighting levels.
iv. Interview Guide - Used to collect detailed qualitative information from selected occupants and building professionals on their experiences and opinions regarding indoor comfort.
v. Secondary Data Sources - Includes journals, textbooks, and previous research studies relevant to indoor environmental quality and building performance.

3.5 Validity and Reliability

Validity

The validity of the research instruments will be ensured through expert review by professionals in architecture and environmental building science. Their feedback will help confirm that the questionnaire, observation checklist, and measurement tools accurately capture Indoor Environmental Quality in both earth-built and conventional buildings.

Reliability

To ensure reliability, a pilot study will be conducted using a small sample of respondents outside the main study area. The instruments will be tested for consistency, and necessary adjustments will be made to improve clarity and ensure dependable and repeatable results during the main study.

3.6 Method of Data Analysis

The data collected for this study will be analyzed using both quantitative and qualitative methods. Quantitative data obtained from questionnaires and environmental measurements will be analyzed using descriptive statistics such as frequency tables, percentages, means, and standard deviation to compare Indoor Environmental Quality in earth-built and conventional buildings.

Qualitative data from interviews and observations will be analyzed using thematic analysis, where responses are grouped into key themes such as thermal comfort, indoor air quality, lighting conditions, and acoustic performance. This combined approach will help provide a comprehensive understanding of differences in indoor environmental quality between the two building types.

3.7 Ethical Considerations

This study will be conducted in line with acceptable research ethics. Permission will be obtained from building owners or relevant authorities before data collection begins. Participation of respondents will be voluntary, and informed consent will be sought from all participants.

Confidentiality and anonymity of respondents will be strictly maintained, and all data collected will be used

solely for academic purposes. Respondents will also have the right to withdraw from the study at any stage without any form of penalty or pressure.

IV. RESULTS AND DISCUSSION

4.1 Demographic Profile of Respondents

The demographic profile of respondents provides background information on the occupants of both earth-built and conventional buildings used in this study. A total of 80 respondents participated, with equal representation from both building types.

Out of the 80 respondents, 46 (57.5%) were male while 34 (42.5%) were female, indicating a fairly balanced gender representation.

The majority of respondents, 42 (52.5%), were within the age range of 26-40 years, 25 (31.25%) were between 18-25 years, while 13 (16.25%) were above 40 years.

The occupational distribution shows that 35 respondents (43.75%) were residents, 28 (35%) were workers/staff, and 17 (21.25%) were students.

Exactly 40 respondents (50%) were occupants of earth-built buildings, while the remaining 40 respondents (50%) were from conventional buildings.

Overall, the demographic distribution shows a balanced representation across gender, age, occupation, and building type, ensuring that the study provides a fair comparison of Indoor Environmental Quality experiences.

4.2 Findings

The findings show that earth-built buildings consistently recorded higher levels of indoor environmental satisfaction compared to conventional buildings across most IEQ indicators.

For thermal comfort, earth-built buildings performed significantly better, with most respondents reporting stable indoor temperatures and reduced reliance on mechanical cooling systems. Conventional buildings showed lower satisfaction, indicating greater temperature fluctuations and higher dependence on artificial cooling.

In terms of indoor air quality, both building types showed moderate performance, but earth-built buildings still recorded slightly better outcomes, likely due to improved natural ventilation and breathable wall materials.

For lighting and visual comfort, conventional buildings performed better in artificial lighting availability, while earth-built buildings recorded higher satisfaction in natural daylight use. This reflects the differences in design approaches between both building types.

Regarding acoustic comfort, earth-built buildings showed clearly superior performance, with respondents reporting lower noise intrusion and better sound insulation compared to conventional buildings.

4.3 Interpretation of findings

The results demonstrate that earth-built buildings generally provide better Indoor Environmental Quality than conventional buildings, particularly in thermal comfort and acoustic performance. This can be attributed to the high thermal mass of earth materials, which helps regulate indoor temperature naturally and reduce external noise penetration.

Conventional buildings, although better equipped with artificial lighting systems, rely heavily on mechanical solutions to maintain comfort conditions, which may not always provide stable or energy-efficient indoor environments. This aligns with previous studies that highlight the limitations of conventional construction in achieving passive environmental control.

The findings also suggest that earth-built structures offer a more balanced and environmentally responsive indoor environment, especially in tropical climates where heat and ventilation are critical factors. However, conventional buildings still maintain advantages in lighting control and design flexibility.

Overall, the study confirms that material choice and construction method significantly influence Indoor Environmental Quality, and integrating earth-based or hybrid sustainable materials into modern

construction could improve occupant comfort and building performance.

V. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This study carried out a comparative analysis of Indoor Environmental Quality (IEQ) in earth-built and conventional buildings, focusing on thermal comfort, indoor air quality, lighting, and acoustic performance. The findings revealed clear differences between the two building types in terms of occupant experience and environmental performance.

Earth-built buildings consistently demonstrated better performance in thermal comfort and acoustic control due to their natural material properties and high thermal mass, which help regulate indoor temperatures and reduce noise penetration. Conventional buildings, on the other hand, showed relatively better performance in artificial lighting provision but depended more on mechanical systems to maintain acceptable indoor conditions.

Overall, the study concludes that earth-built buildings provide a more stable and naturally comfortable indoor environment compared to conventional buildings, particularly in tropical climates. The results highlight the importance of material selection and passive design strategies in improving Indoor Environmental Quality and support the adoption of more sustainable building approaches in future construction practices.

5.2 Recommendation

Based on the findings of the study, the following recommendations are made:

i. Architects and builders should incorporate more earth-based and natural materials in building design to improve thermal comfort and acoustic performance.
ii. Conventional building designs should be enhanced with passive design strategies such as improved ventilation, shading devices, and thermal insulation to improve Indoor Environmental Quality.
iii. Building codes and standards should encourage the use of sustainable and climate-responsive materials, especially in tropical regions.
iv. Future developments should adopt hybrid construction approaches that combine the strengths of both earth-built and conventional systems.
v. Further research should be conducted on long-term performance and durability of earth-built structures in different environmental conditions.

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