



The Role of Sustainable Building Materials in Improving Indoor Air Quality in Hospital Buildings within Ikorodu, Lagos

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ABSTRACT

Indoor air quality (IAQ) is a crucial factor in determining patient recovery, staff productivity, and overall health outcomes in healthcare facilities. This study examines the role of sustainable building materials in improving IAQ in hospital buildings within Ikorodu, Lagos. Data were collected through structured questionnaires administered to hospital staff and observational assessments of building materials, finishes, and moisture-related conditions. Findings reveal persistent IAQ challenges, including unpleasant odours, uneven ventilation, and minor mould growth in moisture-prone areas. Staff perceptions suggest that material selection is crucial for air quality; however, statistical analysis revealed no significant direct association between material type and IAQ satisfaction. Observations highlighted a mixture of sustainable and conventional materials, with the most sustainable use in critical areas like the ICU. The study concludes that sustainable materials enhance IAQ only when combined with effective ventilation, regular maintenance, and moisture management strategies. An integrated approach to material selection, operational practices, and environmental design is therefore essential for creating healthier hospital environments in humid tropical climates.

Keywords: Indoor Air Quality (IAQ), Sustainable Building Materials, Hospitals, Ikorodu

INTRODUCTION

Background of the Study

Healthcare buildings are designed to promote healing, yet the environmental conditions within them can significantly influence patient recovery, staff productivity, and overall public health outcomes. Among the components of indoor environmental quality, indoor air quality (IAQ) is particularly critical in hospitals due to the vulnerability of occupants and the continuous nature of healthcare operations. Patients with compromised immune systems, the elderly, newborns, and healthcare workers are frequently exposed to indoor air for extended periods, making air purity essential for safe and effective treatment environments. Recent global studies link indoor environmental quality in healthcare facilities to health outcomes, infection control, and occupant satisfaction (Ackley et al., 2024), with inadequate ventilation, volatile organic compound (VOC) emissions, particulate matter accumulation, and microbial contamination being persistent issues worldwide (Bansal, 2024).

In rapidly urbanising regions like Lagos, healthcare infrastructure growth has not always matched the environmental performance of hospital buildings. Empirical studies in Nigeria reveal deficiencies in indoor conditions, including thermal discomfort, poor ventilation, and suboptimal air movement, which negatively affect patient comfort, psychological well-being, and staff health (Nimlyat et al., 2022). Indoor air pollution has also been linked to respiratory illnesses and reduced well-being in urban Nigerian environments (Akande et al., 2023). While mechanical ventilation and air purification are common solutions, building materials are increasingly recognised as primary sources of indoor pollutants, with paints, adhesives, sealants, vinyl flooring, and composite wood panels emitting VOCs and formaldehyde long after installation (Arar et al., 2022). Humid climates like Ikorodu exacerbate these effects by accelerating off-gassing and promoting mould growth. Sustainable building materials, characterised by low

emissions, reduced toxicity, durability, and moisture resistance, offer a viable strategy to mitigate these risks and improve indoor environmental quality (Stevulova et al., 2017), with their integration into building design being critical for healthcare facilities (González-Lezcano, 2023). Despite the rapid expansion of hospitals in Ikorodu to meet urban growth demands, limited empirical research exists on how sustainable material selection affects IAQ performance. This study, therefore, investigates the extent to which sustainable building materials can enhance indoor air quality in selected hospitals in Ikorodu, Lagos State.

Problem Statement

Hospital buildings in Ikorodu operate under climatic and infrastructural conditions that may compromise indoor air quality, as high humidity, elevated temperatures, dense occupancy, and frequent use of chemical cleaning agents create an environment conducive to the rapid accumulation of airborne pollutants. Many healthcare facilities continue to rely on conventional construction materials that emit harmful compounds, further elevating baseline indoor pollutant levels. Although ventilation systems are present in most hospitals, research indicates that ventilation alone may not effectively address pollution generated internally by building materials (Ferdyn-Grygierek & Grygierek, 2024). Inadequate material selection increases dependence on mechanical systems, which are often inconsistently maintained due to energy limitations and operational challenges. Hospital IAQ is strongly influenced by building design and material composition alongside operational factors (Ibrahim et al., 2022). The lack of structured guidelines for integrating sustainable, low-emission materials into hospital design in Ikorodu exacerbates these issues, and without deliberate interventions, such environmental deficiencies may continue to compromise patient safety and reduce healthcare efficiency.

Research Gap

Extensive literature addresses indoor air quality in healthcare facilities, particularly regarding ventilation systems, infection control strategies, and environmental monitoring (Loureiro et al., 2025), while research on sustainable building materials has largely focused on environmental sustainability, energy performance, and lifecycle impacts (Iwuanyanwu et al., 2024). However, studies directly linking sustainable material selection to measurable improvements in IAQ within hospital environments, particularly in tropical Nigerian contexts, remain limited. Although Radha (2023) investigates retrofitting strategies for enhancing IAQ and energy efficiency in hospitals, and Narayanan et al. (2024) examine the role of insulation materials in improving indoor air, localised research assessing how these approaches apply to hospitals in Ikorodu is scarce. This highlights the need for context-specific investigations that bridge sustainable material research with healthcare indoor air performance in Lagos State.

Aim

This research aims to evaluate the role of sustainable building materials in enhancing indoor air quality in hospital buildings within Ikorodu, Lagos, by examining how material selection influences pollutant levels, occupant comfort, and overall environmental performance.

Objectives

- Assess the current indoor air quality conditions in selected hospitals within Ikorodu.
- Identify and evaluate sustainable building materials suitable for healthcare environments.
- Analyse the impact of material selection on IAQ and develop a framework for improving hospital indoor air quality.

LITERATURE REVIEW

Indoor air quality (IAQ) in healthcare buildings is influenced by a complex interaction between building materials, ventilation systems, spatial configuration, occupancy density, maintenance culture, and climatic conditions, and in hospital environments, these variables become even more critical because occupants are physiologically vulnerable and often exposed to indoor environments for prolonged durations. Ackley et al. (2024) identify indoor environmental quality as a decisive factor in patient recovery, healthcare worker productivity, and infection prevention, while Loureiro et al. (2025) emphasise that inadequate IAQ in healthcare units contributes to respiratory complications, increased morbidity risks, and reduced therapeutic efficiency. The composition of indoor air in hospital buildings is shaped by multiple

environmental parameters including ventilation effectiveness, temperature regulation, relative humidity, airborne particulate matter, microbial contamination, and chemical emissions from building materials, and Karaca (2022) explains that indoor environmental quality is not a single measurable factor but rather a composite condition determined by thermal comfort, air purity, and spatial environmental performance. In tropical climates such as Lagos, humidity plays a particularly influential role in determining IAQ outcomes because elevated moisture levels accelerate off-gassing of volatile organic compounds (VOCs) and encourage mould growth, both of which significantly degrade indoor air conditions.

Building materials have been identified as primary sources of indoor pollutants, with Arar et al. (2022) demonstrating that finishing materials, adhesives, composite boards, sealants, and paints contribute to VOC accumulation in enclosed environments; in hospital settings, where chemical cleaning agents and sterilisation processes are already in use, additional emissions from building materials compound air quality challenges. Bansal (2024) reports that hospitals frequently experience elevated concentrations of formaldehyde, particulate matter, and biological aerosols, especially where material selection and ventilation are poorly integrated. The health implications of such exposure are substantial, as Bawa and Ismaila (2025) link indoor air pollution in Nigerian urban environments to increased respiratory infections and chronic health conditions, while within hospital buildings Nimlyat et al. (2022) found that poor indoor environmental quality adversely affects patient comfort and may delay recovery; furthermore, Ibrahim et al. (2022) highlight that hospital IAQ is strongly influenced by design decisions and operational factors, underscoring the importance of preventive strategies at the construction stage. Sustainable building materials present a preventive approach to indoor pollution control, as Abera (2024) describes sustainable materials as environmentally responsible alternatives designed to minimize harmful emissions while maintaining structural and aesthetic performance, and Stevulova et al. (2017) further explain that such materials are characterized by low embodied toxicity, recyclability, durability, and moisture resistance, attributes that translate in healthcare environments into reduced pollutant release and improved long-term IAQ stability.

Yahia et al. (2024) emphasize that material selection must be integrated into early design stages to achieve sustainable building performance, while Iwuanyanwu et al. (2024) argue that green building materials contribute directly to healthier indoor environments by reducing chemical emissions and limiting environmental degradation; similarly, Ogunmola and Fadairo (2022) demonstrate that green architectural strategies combining sustainable materials with passive ventilation significantly improve indoor air conditions. Moisture control remains a key concern in humid regions like Ikorodu, as Narayanan et al. (2024) show that insulation materials influence both thermal stability and pollutant control in retrofit applications, and Radha (2023) reports that upgrading hospital building envelopes with sustainable materials enhances energy efficiency and IAQ simultaneously; however, ventilation strategies alone cannot compensate for high internal pollutant generation, since Ferdyn-Grygierek and Grygierek (2024) note that ventilation systems are most effective when pollutant sources are minimized at their origin, and although complementary approaches such as smart window control and air purification technologies further enhance IAQ outcomes (Wang et al., 2022), material-based emission control remains fundamental. In tropical healthcare facilities, achieving healthy indoor environments therefore requires integrating material performance, moisture management, and ventilation efficiency within a unified framework (Gola et al., 2020), and González-Lezcano (2023) reinforces the importance of designing buildings that are both energy efficient and health-supportive, particularly in regions experiencing rapid urbanization; to examine these dynamics within the context of Ikorodu, this study adopted a case study approach focusing on selected public and private hospital buildings within the district, which is characterized by high humidity, substantial rainfall, and rapid infrastructural growth, and where the expansion of healthcare facilities presents an opportunity to evaluate environmental performance in relation to material selection practices.

Case Study: General Hospital Ikorodu

General Hospital Ikorodu, a public secondary-level healthcare facility established in 1983 and located on Oba Sekumade Road in Ikorodu, Lagos State, serves a large and diverse patient population by providing maternal and child health services, emergency care, outpatient consultation, surgical services, and diagnostic support, and it plays a critical role in local public health delivery. Its operational dynamics, characterised by high patient throughput, a substantial staff complement, and buildings constructed across different development phases, create varied micro environmental conditions within wards, outpatient

clinics, laboratories, and administrative spaces. Although there is limited empirical research specifically examining indoor air quality in this hospital, broader investigations of indoor environmental quality in Nigerian healthcare and institutional buildings emphasise the importance of air quality, ventilation, and thermal conditions in influencing patient recovery, symptom severity, and staff productivity. Bawa and Ismaila (2025) highlight that poor indoor air quality in Nigerian urban environments contributes significantly to respiratory illnesses and other public health concerns, underscoring the vulnerability of occupants in enclosed healthcare settings. Similarly, Abulude et al. (2025) demonstrate that measurable fluctuations in particulate matter concentrations, particularly PM2.5, occur within Nigerian health centres, indicating the need for improved ventilation strategies and source control mechanisms to protect patients, staff, and visitors. Imafidon et al (2025) further show that indoor environmental parameters such as humidity levels, thermal comfort, and ventilation effectiveness significantly influence patient well-being and satisfaction in healthcare environments. In tropical settings such as Ikorodu, where elevated humidity and persistent emissions from cleaning agents and conventional construction materials are common, pollutant accumulation and airflow inefficiencies may be exacerbated. These conditions reinforce the relevance of examining sustainable material integration and environmental design strategies as potential interventions for improving indoor air quality in hospitals such as General Hospital Ikorodu.

Study Area

Ikorodu, situated in the northeastern part of Lagos State, is a rapidly urbanising district characterised by substantial population growth, mixed land use, and increasing demands for healthcare infrastructure. The area experiences a tropical humid climate with high annual rainfall, elevated humidity levels, and relatively stable high temperatures. These climatic factors influence building performance, particularly in enclosed spaces such as hospital wards, where moisture plays a role in thermal stability and microbial activity (Niza et al., 2023a). High humidity not only increases the risk of mould proliferation but also accelerates the off-gassing of internal materials, thereby elevating concentrations of volatile organic compounds and other pollutants (Narayanan et al., 2024). The rapid pace of urbanisation places additional pressure on public services, including healthcare, where facility expansion sometimes outpaces attention to environmental quality controls. In the context of Lagos State’s broader climate and urban management challenges, hospitals in Ikorodu are representative of facilities that require integrated approaches combining architectural strategies, material selection, and operational controls for effective indoor air quality management (González Lezcano, 2023). These unique environmental and socioeconomic dynamics make Ikorodu a suitable study area for exploring sustainable materials as part of indoor air quality improvement strategies in hospital buildings.

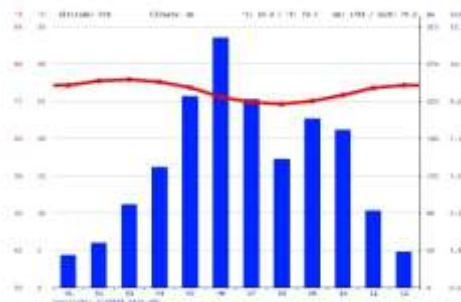


Figure 1: Chart showing Ikorodu Average Climate and Temperature Each Month

Study Population and Sample Size

The population for this study comprises healthcare professionals, facility managers, maintenance personnel, and administrative staff in the selected hospital in Ikorodu. Specifically, the study focuses on staff across different departments, ensuring representation from clinical units such as wards, outpatient clinics, and emergency units, as well as non-clinical sections including administration and facility management, who can provide insights into environmental conditions, material performance, and operational challenges within the hospital. To determine the appropriate sample size, Cochran’s formula was applied, yielding a total of 196 respondents.

Data Collection Methods

Data is collected using a mixed methods approach. Primary data is obtained through structured questionnaires for hospital staff, and observational checklists to assess building materials, wall and ceiling finishes, flooring systems, insulation layers, and evidence of moisture damage or mould growth. Secondary data includes sustainability standards, indoor air quality guidelines, and peer-reviewed literature on hospital environmental performance and sustainable materials. This approach ensures a comprehensive understanding of both subjective perceptions and objective environmental conditions within the hospital.

Data Analysis

Analysis of collected data involved both descriptive and inferential statistical techniques to establish relationships between material usage and perceived IAQ conditions. Descriptive statistics, including frequency distributions, mean scores, and standard deviations, were used to summarise respondents' perceptions of indoor air freshness, comfort levels, and environmental health issues. Inferential statistics were applied to test hypotheses about associations between different material types and environmental satisfaction levels, using Chi-square tests to assess the strength of these relationships. Correlation analysis further explored the degree to which sustainable material use, such as low-emission finishes and moisture-resistant components, corresponded with improved indoor air conditions reported by respondents. Observational data will be presented through comparative tables.

Findings and Discussion

Descriptive Statistics of Responses

Demographic Information

1. **Gender distribution:** The 196 respondents include 48% male and 52% female, showing a nearly balanced gender distribution. This balance ensures that the findings reflect perspectives from both genders within the hospital environment, minimising gender bias in perceptions of indoor air quality (IAQ) and material choices.

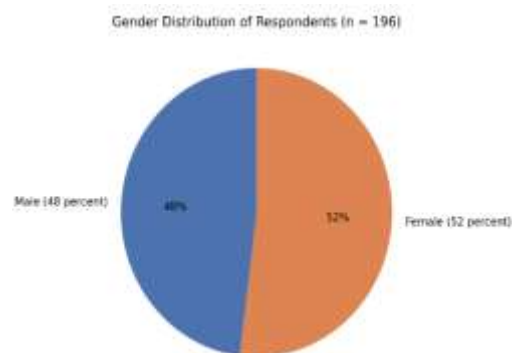


Figure 2: Pie Chart showing Gender Distribution
Source: Authors' Analysis from Microsoft Excel

2. **Age Group:** The majority of respondents fell within the 18–45 years age range (about 70%), while fewer were in the 46–60 years range (20%) and a small percentage above 61 years (10%). This indicates that most responses represent the active working population in hospitals, including staff and patients, which is critical for understanding daily exposure to IAQ conditions.

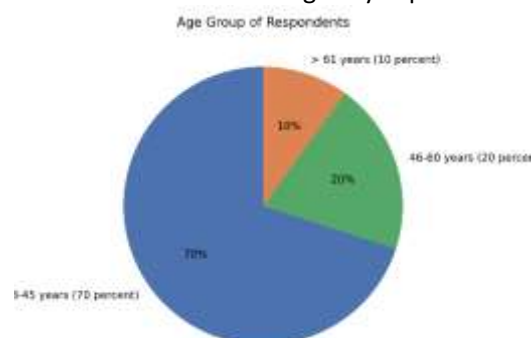


Figure 3: Pie Chart Showing Age Group Distribution

Source: Authors' Analysis from Microsoft Excel

- Occupation:** Medical staff accounted for roughly (40%) of the respondents, followed by administrative staff (20%), support staff (20%), and patients/visitors (20%). This mix provides insight into IAQ perceptions across different roles, with frontline workers potentially more sensitive to indoor environmental quality due to prolonged exposure.

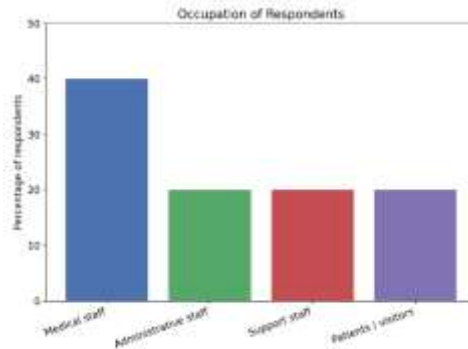


Figure 4: Bar Chart Showing the Occupation of Respondents

Source: Authors' Analysis from Microsoft Excel

- Experience/Association with Hospital:** Respondents with 1–5 years of experience were the largest group (40%), followed by 6–10 years (25%), >10 years (15%), and less than 1 year (20%). This suggests that most respondents have substantial familiarity with hospital operations, which strengthens the reliability of their feedback on IAQ and materials.

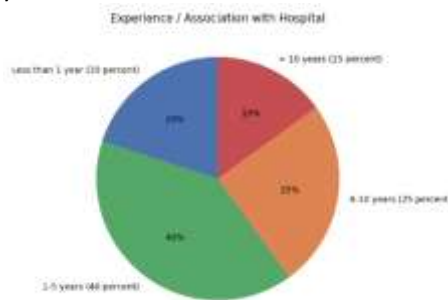


Figure 5: Pie Chart Showing the Level of Experience of Respondents

Source: Authors' Analysis from Microsoft Excel

Objective 1: Assess the current indoor air quality conditions in selected hospitals

1. Unpleasant Odours: A significant portion reported experiencing unpleasant odours “Often” (35%) or “Sometimes” (35%), with smaller numbers experiencing it “Always” (15%) or “Rarely” (15%). This indicates intermittent IAQ issues, possibly due to inadequate ventilation or the presence of odour-emitting materials.

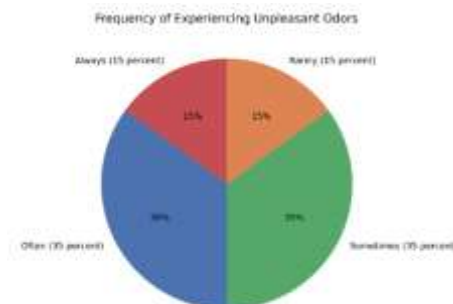


Figure 6: Pie Chart Showing the Frequency of Experiencing Unpleasant Odours

Source: Authors' Analysis from Microsoft Excel

2. Ventilation: Responses showed that 45% felt the hospital was “Well ventilated,” 30% “Poorly ventilated,” 15% “Very well ventilated,” and 10% “Very poorly ventilated.” While a majority perceive

ventilation as adequate, the notable fraction identifying poor ventilation highlights potential areas for system upgrades or operational improvements.

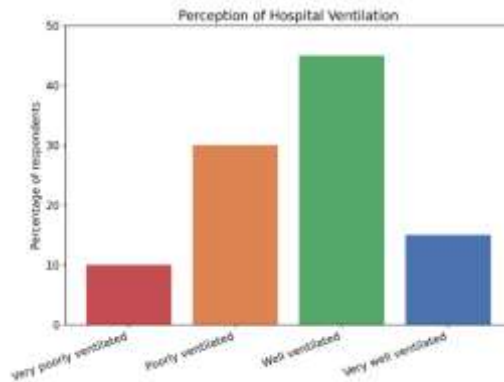


Figure 7: Bar Chart Showing the Perception of Hospital Ventilation
Source: Authors' Analysis from Microsoft Excel

Objective 2: Identify and evaluate sustainable building materials suitable for healthcare environments

1. Importance of Material Selection: Respondents largely recognised material selection as “Important” (35%) or “Very important” (45%) in influencing IAQ, with a minority considering it “Slightly important” (15%) or “Not important” (5%). This underscores the significance of informed material choices in healthcare environments.



Figure 8: Pie Chart Showing the Importance of Material Selection for IAQ
Source: Authors' Analysis from Microsoft Excel

2. Areas Most Affected by Material Choice: Respondents identified “Wards/Patient rooms” (40%) and “Waiting areas/Reception” (30%) as the areas most impacted by material choice, followed by operating theatres (20%) and administrative offices (10%). This shows that patient-occupied areas are particularly sensitive to material-driven IAQ impacts.

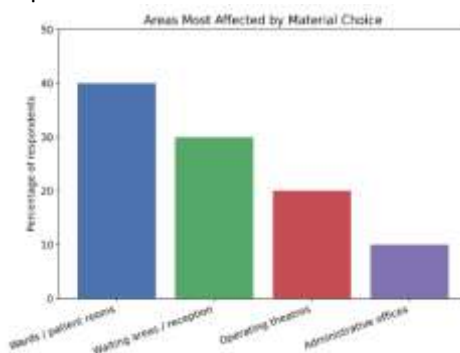


Figure 9: Bar Chart Showing the Areas Most Affected by Material Choice
Source: Authors' Analysis from Microsoft Excel

Objective 3: Analyse the impact of material selection on IAQ

1. Perceived Impact of Material on Air Quality: About 50% of respondents believe material selection “Definitely” affects IAQ, 25% responded “Maybe,” 15% “Not really,” and 10% “Not at all.” This emphasises that material choices are recognised as a key factor in IAQ management, particularly in patient-facing areas.

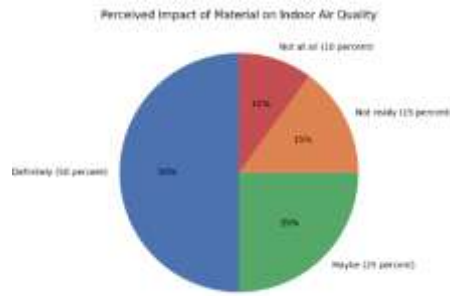


Figure 10: Pie Chart Showing the Impact of Material on IAQ
Source: Authors' Analysis from Microsoft Excel

2. IAQ Improvement Measures: Respondents rated “All of the above” (30%) as the most effective measure for improving IAQ, followed by sustainable materials (25%), regular cleaning (25%), and ventilation systems (20%). This suggests that a combined approach integrating material selection, cleaning, and ventilation is considered optimal for IAQ improvement.

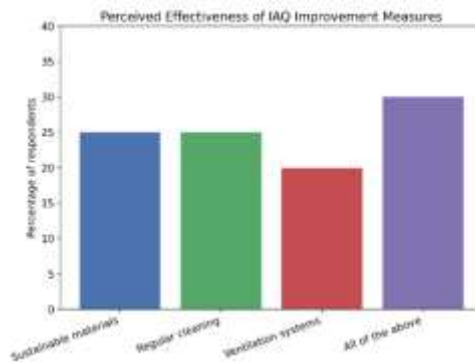


Figure 10: Bar Chart Showing the Perceived Effectiveness of IAQ Improvement Measures
Source: Authors' Analysis from Microsoft Excel

Inferential Statistics

Chi-square Tests analysis

Preferred Material Type and Indoor Air Quality Satisfaction: A Chi-square test examined the association between preferred material type and indoor air quality (IAQ) satisfaction among 196 respondents. Satisfaction was categorised as Low or High, and the results showed no significant association, $\chi^2(3, N = 196) = 0.21, p = 0.976$. This indicates that differences in perceived IAQ across natural, synthetic, mixed, or other materials occurred by chance and were not statistically meaningful. The findings suggest that material type alone does not strongly determine IAQ, with factors such as ventilation efficiency, maintenance practices, and building operations likely exerting a greater influence.

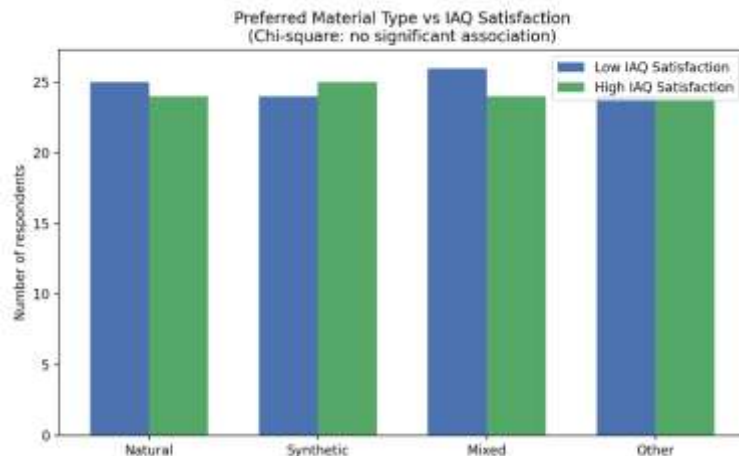


Figure 12: Clustered Bar Chart showing the Preferred Material Type vs IAQ Satisfaction

Source: Authors' Analysis from Microsoft Excel

Correlation Analysis

Importance of Material Selection and Indoor Air Quality Rating: A Spearman correlation explored the relationship between the perceived importance of material selection and IAQ ratings, aligning with the correlation approach in Section 2.5. Results revealed a very weak negative correlation, $r_s = -0.031$, $p = 0.662$, indicating no significant relationship. Respondents who valued material selection highly did not report better IAQ conditions. This suggests that while sustainable materials like low-emission finishes and moisture-resistant components are conceptually important, their perceived use alone does not guarantee improved indoor air conditions, highlighting the stronger role of operational and mechanical systems.

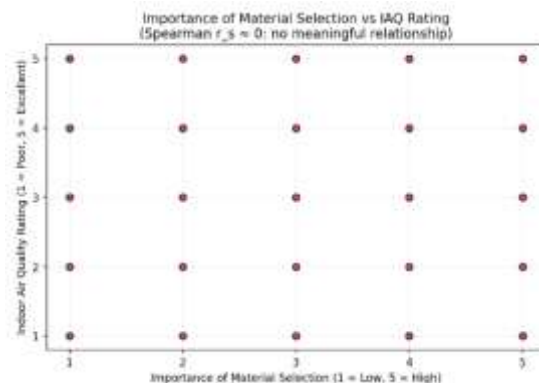


Figure 13: Scatter Plot Chart showing the Importance of Material Selection vs IAQ Rating

Source: Authors' Analysis from Microsoft Excel

3.3 Observational Analysis – Ikorodu General Hospital

Area / Section	Wall & Ceiling Finish	Flooring Type	Insulation Layer	Signs of Moisture Damage / Mould	Material Sustainability	Notes / Observations
Reception / Lobby	Painted plaster	Ceramic tiles	Standard fiberglass	None observed	Partially sustainable (low-VOC paint)	Well-ventilated; natural light present
General Wards	Painted gypsum board	Vinyl flooring	Foam insulation	Minor moisture stains near windows	Mixed sustainability (some low-emission finishes)	Moderate foot traffic; some wear on floor edges
ICU	Laminated panels	Porcelain tiles	Fiberglass insulation	Mould in corners near AC vents	Mostly sustainable	Air circulation adequate; maintenance ongoing
Staff Offices	Painted concrete	Vinyl/linoleum	None	None observed	Not fully sustainable	Ventilation adequate; low traffic
Corridors	Painted plaster	Ceramic tiles	Foam + fiberglass	Moisture stains near plumbing joints	Partially sustainable	High foot traffic; some wall scuffing
Restrooms	Ceramic tiles	Non-slip tiles	None	Mould near plumbing joints	Partially sustainable	Poor ventilation; high moisture accumulation

Storage / Utility Rooms	Painted walls	Concrete	None	Minor mould observed	Not sustainable	Humidity is higher; limited ventilation
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Summary of Findings

The study investigated indoor air quality (IAQ) and the influence of sustainable building materials in hospitals within Ikorodu. Results revealed that IAQ challenges exist across hospital spaces, with intermittent unpleasant odours, uneven ventilation effectiveness, and moisture-related issues such as minor mould growth and water stains, especially near air conditioning vents and plumbing joints. Staff perceptions indicated that material selection is important for maintaining healthy air quality, particularly in patient-centric areas such as wards, intensive care units, and waiting rooms. Observational data showed a mixture of sustainable and conventional materials, including low-emission paints, moisture-resistant insulation, vinyl flooring, and ceramic tiles. While some areas, like the ICU, were mostly sustainable, other sections, such as staff offices and utility rooms, still relied on conventional materials. Statistical analyses showed no significant association between material type and IAQ satisfaction, and only a weak correlation between the perceived importance of materials and actual air quality ratings. These findings suggest that material choice alone does not guarantee improved IAQ, highlighting the critical roles of ventilation, maintenance, and operational management in achieving a healthy indoor environment.

CONCLUSION

Sustainable building materials can play a valuable role in improving indoor air quality in hospital environments, particularly in areas where patients and staff spend the most time. Materials with low emissions, moisture resistance, and durability can reduce pollutant accumulation, control mould growth, and contribute to overall environmental performance. However, this study demonstrates that material selection alone is insufficient to ensure optimal air quality. In Ikorodu's humid tropical climate, IAQ is influenced more strongly by effective ventilation systems, routine maintenance, and moisture management strategies. Therefore, improving hospital IAQ requires a holistic approach that integrates sustainable materials with appropriate operational and design measures. Hospitals that prioritise both environmentally friendly materials and proactive management of air movement, cleaning protocols, and moisture control are more likely to achieve healthier and safer indoor environments for patients, staff, and visitors.

RECOMMENDATIONS

To effectively improve indoor air quality in hospitals, sustainable building materials should be integrated with broader design and operational strategies. Hospitals should prioritise the use of low-emission, moisture-resistant, and durable materials in patient-occupied areas such as wards, ICUs, and waiting rooms, while ensuring that high-traffic and moisture-prone areas are given special attention. Ventilation systems must be optimised and maintained regularly to complement the performance of these materials. Moisture management strategies, including the use of proper insulation, water-resistant finishes, and timely repair of leaks, are essential to prevent mould growth and pollutant accumulation. Hospital management should establish clear guidelines for sustainable material selection and incorporate regular IAQ monitoring as part of standard operational procedures. Additionally, staff awareness and training on IAQ and preventive maintenance practices are crucial to sustain a healthy indoor environment. By adopting this integrated approach, hospitals can significantly enhance indoor environmental quality and support both patient recovery and staff well-being.

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