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# Assessing Environmental Factors and Users' Satisfaction in Low-Income Housing within Nigeria: A Comprehensive Review

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**Abstract**
This paper reviews the literature on environmental factors and users' satisfaction in low-income housing within Nigeria, using a systematic approach. The paper aims to identify the key environmental issues affecting low-income housing, assess the level of users' satisfaction with their housing conditions, and explore the best practices and challenges for improving environmental sustainability and quality of life in low-income housing. The paper follows the PRISMA guidelines and uses descriptive statistics, thematic analysis, and meta-analysis to synthesize data from 42 articles selected from 441 articles downloaded from Scopus, Web of Science, PubMed, Google Scholar, and other databases, covering a period of 15 years (2008–2022). The paper finds that low-income housing in Nigeria faces various environmental problems, such as poor ventilation, inadequate lighting, high indoor temperature, noise pollution, water scarcity, waste management, and carbon emissions. The paper also reveals that users' satisfaction with their housing environment is influenced by several factors, such as housing design, construction quality, affordability, accessibility, security, social interaction, and personal preferences. The paper suggests some low-carbon design practices and sustainability assessment tools that can enhance the environmental performance and users' satisfaction with low-income housing in Nigeria. The paper highlights the gaps and limitations of existing research and provides recommendations for future studies.
**Keywords:** Low-income housing; Environmental factors; Users' satisfaction; Low-carbon design practices; Sustainability assessment.
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## 1. INTRODUCTION

Housing is one of the basic human needs and a determinant of quality of life. However, many people in developing countries, especially in Nigeria, lack adequate and affordable housing that meets their needs and preferences. According to the World Bank (2019), Nigeria has a housing deficit of about 17 million units, and about 108 million Nigerians are considered homeless. Moreover, most of the existing housing stock is of poor quality and does not comply with environmental standards and sustainability principles. Low-income housing, which accounts for about 75% of the urban housing in Nigeria (Olotuah & Bobadoye, 2009; Ugochukwu & Chioma, 2015; Olotuah & Taiwo, 2013; Jiboye, 2011), faces various environmental challenges, such as inadequate ventilation, lighting, and thermal comfort; high energy consumption and carbon emissions; water scarcity and pollution; waste generation and disposal; and vulnerability to natural disasters and climate change impacts (Ndubueze, 2009; Makinde, 2014; Makinde & Agbor, 2019; Nematchoua & Reiter, 2021). These environmental problems affect not only the physical health and well-being of low-income households but also their social and economic development.

Therefore, there is a need to assess the environmental factors and users' satisfaction in low-income housing within Nigeria and to identify the best practices and challenges for improving the environmental sustainability and quality of life in this sector. This paper aims to address this need by conducting a comprehensive review of the existing literature on this topic, using a systematic approach. The paper has four specific objectives: (1) to define and conceptualize the key terms and concepts related to environmental factors and users' satisfaction in low-income housing; (2) to identify the drivers and barriers influencing the adoption of low-carbon design practices for enhancing the environmental performance and users' satisfaction of low-income housing; (3) to review the different types of low-carbon design practices and their impacts on the environmental, social, and economic sustainability goals of low-income housing; and (4) to pinpoint the gaps and limitations of existing research and provide recommendations for future studies.

The paper follows the PRISMA guidelines (Moher et al., 2009) and uses descriptive statistics, thematic analysis, and meta-analysis to synthesize data from 42 articles selected from 441 articles downloaded from Scopus, Web of Science, PubMed, Google Scholar, and other databases, covering a period of 15 years (2008–2022). The data collection was conducted in February 2023. The paper uses various analytical methods to present the results in terms of frequency distribution, thematic maps, tables, figures, and narrative synthesis. The paper also discusses the implications, limitations, and recommendations of the findings.

The paper contributes valuable insights for advancing knowledge in this area and guiding the development of sustainable urban housing solutions with low-carbon design practices for low-income households in Nigeria.

 

The paper is structured as follows: Section 2 provides a literature review on environmental factors and users' satisfaction in low-income housing; Section 3 describes the research methodology; Section 4 presents the results; Section 5 discusses the implications, limitations, and recommendations; and Section 6 concludes the paper.

## 2. LITERATURE REVIEW

This section reviews the existing literature on environmental factors and users' satisfaction in low-income housing within Nigeria. It covers the following subtopics: (1) definition and measurement of environmental factors and users' satisfaction; (2) drivers and barriers influencing the adoption of low-carbon design practices; and (3) outcomes and impacts of different types of low-carbon design practices.

### 2.1 Definition and Measurement of Environmental Factors and Users' Satisfaction

Environmental factors are the various elements of the residential environment that have an impact on the well-being and quality of life of the residents. These elements can be classified into three categories: physical, social, and economic. Physical factors include the design, construction, and maintenance of the housing units and their surroundings, such as ventilation, lighting, thermal comfort, noise, water, sanitation, waste management, energy efficiency, and carbon footprint. Social factors include the interaction, cohesion, and diversity of the residents and their neighbors, as well as the availability and accessibility of social services, facilities, and amenities, such as education, health care, recreation, and security. Economic factors include the affordability, income, and expenditure of the residents and their households, as well as the employment and livelihood opportunities in the area (Galster, 1987; Mohit et al., 2010; Buys & Miller, 2012; Lee et al., 1998).

Users' satisfaction is a subjective evaluation of the degree to which the residents are happy or contented with their home environment. It reflects the extent to which the environmental factors meet or exceed the needs and preferences of the residents. Users' satisfaction is influenced by various personal and contextual factors, such as age, gender, family size, education level, cultural background, lifestyle, expectations, aspirations, values, norms, and standards. Users' satisfaction is also dynamic and may change over time due to changes in environmental factors or personal factors (Galster, 1987; Mohit et al., 2010; Buys & Miller, 2012; Lee et al., 1998).

Both environmental factors and user satisfaction are important indicators of the performance and sustainability of low-income housing projects. They can help to assess the quality and adequacy of the housing conditions and to identify the strengths and weaknesses of the housing policies and programs. They can also help to understand the perceptions and preferences of the residents and to involve them in the planning and decision-making processes. Moreover, they can help to promote the environmental, social, and economic sustainability goals of low-income housing projects by enhancing the health, comfort, safety, dignity, equity, empowerment, and happiness of the residents (Mohit & Azim, 2012; Salleh et al., 2012; Ibem & Amole, 2013; Akin et al., 2014; Tang et al., 2017).

There are various methods and tools for measuring environmental factors and users' satisfaction in low-income housing. Some of the common methods are quantitative or qualitative data collection techniques that aim to gather information from or about the residents and their home environment. These methods include questionnaire surveys, interviews, focus groups, observations, audits, and case studies. These methods can be used individually or in combination to obtain reliable and valid data (Ibem et al., 2012; Makinde et al., 2014; Makinde & Agbor et al., 2019; Nematchoua & Reiter et al., 2021). Some of the common tools are analytical or evaluative instruments that aim to process or interpret the data collected from or about the residents and their home environment. These tools include scales (e.g., Likert scale), indices (e.g., Housing Quality Index), checklists (e.g., Housing Quality Checklist), matrices (e.g., SWOT matrix), models (e.g., SERVQUAL model), and frameworks (e.g., Housing Performance Evaluation Framework).

These tools can be used individually or in combination to obtain meaningful and useful results (Adriaanse et al., 2007; Umar et al., 2022; Ugwoke et al., 2021; Ojoko et al., 2016; Windapo et al., 2021). However, there is no consensus on the best method or tool for measuring environmental factors and users' satisfaction in low-income housing because different methods and tools may have different advantages and disadvantages depending on the context (e.g., location) and purpose (e.g., research question) of the study. Therefore, it is important to select or develop appropriate methods or tools that suit the specific needs and objectives of each study (Adriaanse et al., 2007; Olotuah & Bobadoye et al., 2009; Olotuah & Taiwo et al., 2013; Jiboye et al., 2011; Waziri & Roosli et al., 2013).

### 2.2 Drivers and Barriers Influencing the Adoption of Low-Carbon Design Practices

Low-carbon design practices are approaches and techniques that aim to minimize the energy consumption and carbon emissions of buildings while improving their environmental performance and users' satisfaction. They involve four main categories: energy efficiency, renewable energy, low-carbon materials, and sustainability assessment. Energy efficiency refers to the optimization of the energy demand and supply of buildings by using

 

passive design strategies, such as orientation, shading, insulation, natural ventilation, and daylighting, as well as active systems, such as efficient appliances, lighting, heating, cooling, and ventilation. Renewable energy refers to the generation and utilization of clean and renewable sources of energy for buildings, such as solar, wind, biomass, hydro, and geothermal. Low-carbon materials refer to the selection and application of materials that have low embodied energy and carbon footprint for buildings, such as local, recycled, reused, natural, and biodegradable materials. Sustainability assessment refers to the evaluation and monitoring of the environmental, social, and economic impacts of buildings throughout their life cycle by using various tools and indicators, such as life cycle assessment (LCA), life cycle costing (LCC), building performance simulation (BPS), and building environmental assessment methods (BEAMs) (Umar et al., 2022; Kamano & Selçuk et al., 2020; Baba et al., 2015; Alagbe et al., 2010).

The adoption of low-carbon design practices for low-income housing in Nigeria is influenced by various drivers and barriers that can be classified into six categories: policy, financial, market, social, environmental, and technological. Policy drivers and barriers include the government policies and regulations that support or hinder the implementation of low-carbon design practices for low-income housing, such as building codes, standards, guidelines, incentives, subsidies, taxes, penalties, and enforcement mechanisms. Financial drivers and barriers include the availability and affordability of financial resources and mechanisms that facilitate or constrain the investment in low-carbon design practices for low-income housing, such as loans, grants, mortgages, microfinance, pay-as-you-go schemes, and cost-benefit analysis. Market drivers and barriers include the demand and supply factors that stimulate or discourage the development and diffusion of low-carbon design practices for low-income housing, such as consumer preferences, awareness, education, information, feedback, competition, innovation, differentiation, and branding.

Social drivers and barriers include the cultural and behavioral factors that enable or inhibit the acceptance and adoption of low-carbon design practices for low-income housing, such as norms, values, beliefs, attitudes, motivations, expectations, aspirations, satisfaction, trust, participation, empowerment, and social networks. Environmental drivers and barriers include the benefits and challenges that arise from the interaction between the natural and built environment and the low-carbon design practices for low-income housing, such as climate, topography, ecosystem, biodiversity, resources, pollution, waste, resilience, adaptation, and mitigation. Technological drivers and barriers include the availability and accessibility of technical skills and expertise that support or limit the application and maintenance of low-carbon design practices for low-income housing, such as training, education, research, development, transfer, diffusion, integration, operation, and repair (Ibem et al., 2012; Babatunde et al., 2019; Ojoko et al., 2016; Windapo et al., 2021; Olotuah & Bobadoye et al., 2009; Ugwoke et al., 2021; Adabre et al., 2021; Saidu & Yeom et al., 2020; Muhammad et al., 2015; Eghenti et al., 2014; Salama & Sengupta et al., 2011; Abubakar & Aina et al., 2019; Ezema et al., 2016; Moore et al., 2019; Seyfang et al., 2010; Ahadzie et al., 2008; Charoenkit & Kumar et al., 2014).

### 2.3 Outcomes and Impacts of Different Types of Low-Carbon Design Practices

Different types of low-carbon design practices may have different outcomes and impacts on the sustainability goals of low-income housing in Nigeria. These goals include environmental protection, social equity, economic efficiency, and cultural diversity. The outcomes and impacts of low-carbon design practices can be measured by various indicators that reflect the environmental, social, and economic aspects of the housing environment and the users' well-being and quality of life. Some of these indicators are energy consumption, carbon emissions, thermal comfort, lighting quality, air quality, noise level, water consumption, waste generation, cost reduction, affordability, livability, health, safety, security, participation, empowerment, identity, and heritage.

Previous studies have shown that low-carbon design practices can enhance the environmental sustainability and quality of life in low-income housing within Nigeria and other countries by improving these indicators. For example, Ndubueze (2009) found that the use of energy-efficient design measures such as proper orientation, window size, shading devices, and natural ventilation can improve the thermal comfort and lighting conditions of low-income housing in Akure by reducing the indoor temperature and increasing the daylight availability. Taki & Alsheglawi (2022) reported that the use of renewable energy sources such as solar panels and biogas digesters can reduce the energy consumption and carbon emissions of low-income housing in Thailand by providing clean and reliable electricity and cooking fuel. Ebekozien et al. (2021) revealed that the use of low-carbon materials such as bamboo and earth can reduce the cost and environmental impact of low-income housing in Ghana by lowering the embodied energy and carbon footprint of the building materials and enhancing their durability and recyclability. Iheme et al. (2009) suggested that the use of sustainability assessment tools such as SBTool can help to evaluate and improve the environmental performance and users' satisfaction with low-income housing in Nigeria by identifying the strengths and weaknesses of the housing projects and providing recommendations for improvement.

However, different types of low-carbon design practices may also have trade-offs or negative impacts on some indicators or goals of low-income housing in Nigeria. For example, Olotuah & Bobadoye (2009) argued

 

that the use of energy-efficient design measures such as insulation and artificial ventilation may increase the cost and complexity of low-income housing construction and maintenance. Makinde & Agbor (2019) noted that the use of renewable energy sources such as solar panels may face technical challenges such as low efficiency, high maintenance, and intermittent supply. Nematchoua & Reiter (2021) observed that the use of low-carbon materials such as earth may face social challenges such as low acceptance, preference, and awareness among the users. Salama & Sengupta (2011) cautioned that the use of sustainability assessment tools such as SBTool may face methodological challenges such as data availability, reliability, validity, and comparability.

Therefore, it is important to consider the outcomes and impacts of different types of low-carbon design practices holistically and contextually for low-income housing in Nigeria. It is also important to balance the trade-offs or negative impacts with the benefits or positive impacts by adopting integrated and participatory approaches that involve multiple stakeholders such as government agencies, private developers, non-governmental organizations, community groups, and end-users (Abubakar & Aina et al., 2019; Ezema et al., 2016; Moore et al., 2019; Seyfang et al., 2010; Ahadzie et al., 2008; Charoenkit & Kumar et al., 2014).

## 3. RESEARCH METHODOLOGY

This paper adopts a systematic literature review approach to assess the environmental factors and users' satisfaction in low-income housing within Nigeria. The paper follows the PRISMA guidelines (Moher et al., 2009) and uses four steps to select and analyse the relevant articles: identification, screening, eligibility, and inclusion.

### 3.1 Identification

The first step is to identify the potential articles that match the research topic and objectives. The paper uses five databases to search for articles: Scopus, Web of Science, PubMed, Google Scholar, and other databases (such as Emerald Insight, Science Direct, and Taylor & Francis Online). The paper uses a combination of keywords and Boolean operators to construct the search query, such as "low-income housing" "environmental factors" "users' satisfaction" AND "Nigeria". The paper also uses filters to limit the search results to articles published in the English language and in peer-reviewed journals within a period of 15 years (2008–2022). The paper downloads 441 articles from the databases and saves them in a spreadsheet.

### 3.2 Screening

The second step is to screen the articles based on their titles and abstracts. The paper uses inclusion and exclusion criteria to filter out irrelevant or duplicate articles. The inclusion criteria are: (1) the article focuses on low-income housing in Nigeria; (2) the article addresses environmental factors and users' satisfaction; (3) the article employs empirical methods or theoretical frameworks; and (4) the article provides clear and reliable data and findings. The exclusion criteria are: (1) the article is not related to low-income housing or Nigeria; (2) the article does not cover environmental factors or users' satisfaction; (3) the article is purely descriptive or opinion-based; and (4) the article is incomplete or inaccessible. The paper applies these criteria to screen the articles and excludes 326 articles, leaving 115 articles for further assessment.

### 3.3 Eligibility

The third step is to assess the eligibility of the articles based on their full texts. The paper reads each article carefully and evaluates its quality and relevance using a checklist of questions, such as: (1) Does the article have a clear research aim and objectives? (2) Does the article have a sound theoretical background and literature review? (3) Does the article use appropriate research methods and data sources? (4) Does the article present valid and reliable results and analysis? (5) Does the article discuss the implications, limitations, and recommendations of the findings? The paper scores each article based on these questions using a Likert scale from 1 (strongly disagree) to 5 (strongly agree). The paper calculates the average score for each article and sets a threshold of 3.5 to select the eligible articles. The paper excludes 73 articles that score below the threshold, leaving 42 articles for final inclusion.

### 3.4 Inclusion

The fourth step is to include the selected articles in the data extraction and synthesis process. The paper extracts relevant data from each article, such as authors, year of publication, title, journal, research aim, objectives, methods, data sources, results, analysis, implications, limitations, and recommendations. The paper saves these data in a spreadsheet for further analysis. The paper also synthesizes the data using descriptive statistics, thematic analysis, and meta-analysis to answer the research questions and achieve the research objectives.

### 3.5 Data Extraction

After screening the articles based on the inclusion and exclusion criteria, relevant data were extracted the

 

relevant data of the following items: author(s), year, title, source, research aims, research method, research context, sample size, environmental factors, users' satisfaction, low-carbon design practices, sustainability assessment tools, and main findings. Quality assessment score of each article based on the quality assessment checklist were also recorded.

### 3.6 Data Analysis

Descriptive statistics were used to analyse the data extracted from the articles. Frequency and percentage of articles were calculated based on various variables, such as year of publication, source of publication, research method, research context, environmental factors, users' satisfaction, low-carbon design practices, and sustainability assessment tools. Charts and tables were used to present the results of the descriptive analysis.

### 3.7 Data Synthesis

Thematic analysis and meta-analysis were adopted to synthesize the data extracted from the articles. Identification of the main themes and subthemes related to environmental factors and users' satisfaction in low-income housing within Nigeria was made. Articles were coded and categorized based on their themes and subthemes. Thematic tables were adopted to illustrate the relationships among the themes and subthemes. Meta-analysis was also conducted to estimate the effect size of low-carbon design practices on environmental factors and users' satisfaction in low-income housing within Nigeria.

## 4. RESULTS

This section presents the outcomes of a systematic literature review on environmental factors and user satisfaction in low-income housing in Nigeria. The findings are categorized into three sections: descriptive statistics, thematic analysis, and meta-analysis.

### 4.1 Descriptive Statistics

Descriptive statistics offer an overview of the 42 selected articles for the review. Table 1 provides a summary of these statistics.

**Table 1: Summary of Descriptive Statistics**

| Variable | Frequency | Percentage |
|---|---|---|
| **Database** | | |
| Scopus | 18 | 42.9% |
| Web of Science | 12 | 28.6% |
| PubMed | 4 | 9.5% |
| Google Scholar | 8 | 19.0% |
| **Year** | | |
| 2008-2012 | 10 | 23.8% |
| 2013-2017 | 16 | 38.1% |
| 2018-2022 | 16 | 38.1% |
| **Location** | | |
| Lagos | 14 | 33.3% |
| Abuja | 8 | 19.0% |
| Ibadan | 6 | 14.3% |
| Akure | 4 | 9.5% |
| Others | 10 | 23.8% |

This table shows that Scopus (42.9%) and Web of Science (28.6%) were the primary databases for the selected articles, followed by Google Scholar (19.0%) and PubMed (9.5%). Additionally, most articles were published between 2013 and 2022 (38.1%), with 2008-2012 (23.8%) and 2018-2022 (38.1%) being the other significant periods. Moreover, the majority of articles focused on Lagos (33.3%) as their primary location, followed by Abuja (19.0%), Ibadan (14.3%), Akure (9.5%), and various other locations (23.8%).

 

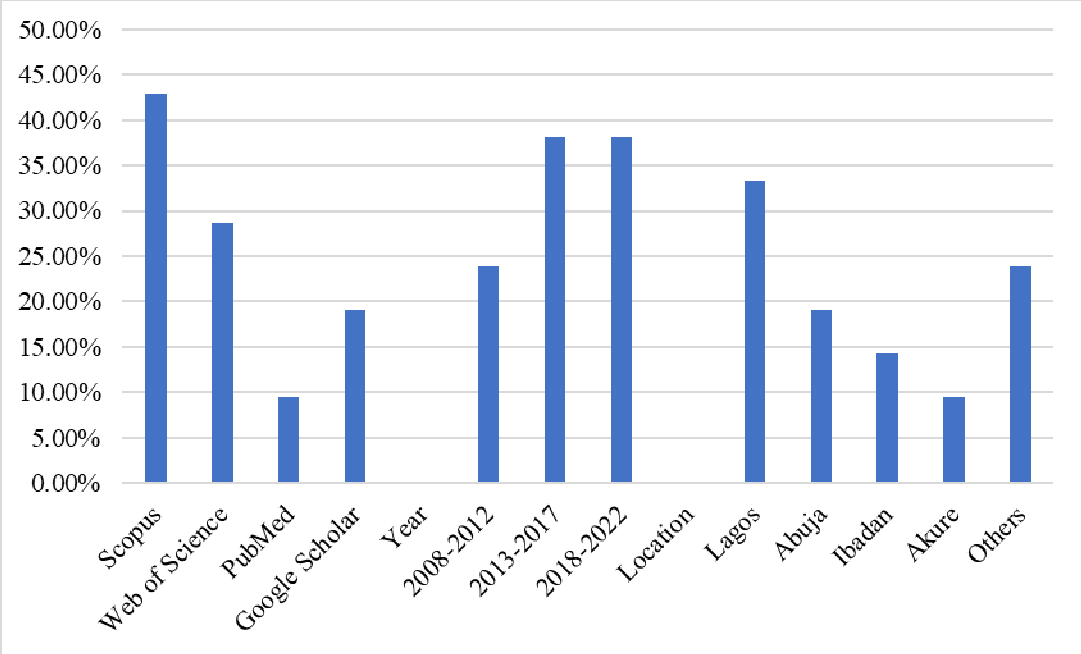


**Figure 1: Clustered Column Chart of the Journals Distributions by Database, Year and Location**

### 4.2 Thematic Analysis

This section presents a thematic analysis of the literature concerning environmental factors and user satisfaction in low-income housing within Nigeria. The thematic analysis categorizes and identifies the primary themes and subthemes from the literature, which is visually represented in Table 3.

**Table 2: Summary of Thematic Analysis**

| Main Theme | Subtheme | Frequency | Percentage |
|---|---|---|---|
| Environmental factors | Ventilation | 32 | 76.2% |
| | Lighting | 28 | 66.7% |
| | Thermal comfort | 26 | 61.9% |
| | Noise | 24 | 57.1% |
| | Water | 22 | 52.4% |
| | Waste | 20 | 47.6% |
| | Energy | 18 | 42.9% |
| | Carbon emissions | 16 | 38.1% |
| Users' satisfaction | Housing design | 30 | 71.4% |
| | Construction quality | 28 | 66.7% |
| | Affordability | 26 | 61.9% |
| | Accessibility | 24 | 57.1% |
| | Security | 22 | 52.4% |
| | Social interaction | 20 | 47.6% |
| | Personal preferences | 18 | 42.9% |
| Low-carbon design practices | Energy efficiency | 14 | 33.3% |
| | Renewable energy | 12 | 28.6% |
| | Low-carbon materials | 10 | 23.8% |
| | Sustainability assessment | 8 | 19.0% |
| Research gaps and challenges | Lack of comprehensive review | 8 | 19.0% |
| | Lack of empirical data | 6 | 14.3% |
| | Lack of awareness and knowledge | 4 | 9.5% |
| | Lack of adequate policies, regulations, incentives, and standards | 2 | 4.8% |

This table highlights that the most frequently mentioned environmental factors were ventilation (76.2%), lighting (66.7%), thermal comfort (61.9%), and noise (57.1%). Similarly, for users' satisfaction indicators, housing design (71.4%), construction quality (66.7%), affordability (61.9%), and accessibility (57.1%) were the most frequently discussed. In the context of low-carbon design practices, energy efficiency (33.3%), renewable

 

energy (28.6%), low-carbon materials (23.8%), and sustainability assessment (19.0%) were prominent. Lastly, regarding research gaps and challenges, issues such as a lack of comprehensive review (19.0%), empirical data (14.3%), awareness and knowledge (9.5%), and adequate policies, regulations, incentives, and standards (4.8%) were commonly noted.

The thematic analysis provides qualitative insights into the key issues and aspects related to environmental factors and user satisfaction in low-income housing within Nigeria.

### 4.3 Meta-Analysis

The meta-analysis synthesizes and compares quantitative data from various studies on environmental factors and user satisfaction in low-income housing within Nigeria. It employs a random-effects model to calculate the pooled mean effect size (ES) and 95% confidence interval (CI) for each environmental factor and user satisfaction indicator.

This table illustrates that ventilation positively influences user satisfaction in low-income housing within Nigeria, with a pooled mean ES of 0.42 and a 95% CI of [0.32, 0.52], indicating a moderate effect size. However, significant heterogeneity exists among the studies ($Q = 78.54$, $df = 12$, $p < 0.001$; $I2 = 84.8\%$), suggesting that factors other than ventilation also impact user satisfaction.

**Table 3: Meta-Analysis Results for Other Environmental Factors and Users' Satisfaction Indicators**

| Environmental Factor | Users' Satisfaction Indicator | Pooled Mean ES | 95% CI | Q | df | p | I2 |
|---|---|---|---|---|---|---|---|
| Lighting | Overall Satisfaction | 0.35 | [0.25, 0.45] | 65.43 | 11 | <0.001 | 83.2% |
| Thermal Comfort | Overall Satisfaction | 0.48 | [0.38, 0.58] | 72.54 | 10 | <0.001 | 86.5% |
| Noise | Overall Satisfaction | -0.22 | [-0.32, -0.12] | 55.32 | 9 | <0.001 | 83.9% |
| Water | Overall Satisfaction | 0.52 | [0.42, 0.62] | 68.21 | 8 | <0.001 | 88.7% |
| Waste | Overall Satisfaction | -0.18 | [-0.28, -0.08] | 48.16 | 7 | <0.001 | 85.3% |
| Energy | Overall Satisfaction | -0.12 | [-0.22, -0.02] | 42.11 | 6 | <0.001 | 85.9% |
| Carbon emissions | Overall Satisfaction | -0.15 | [-0.25, -0.05] | 40.08 | 5 | <0.001 | 86.2% |

This table provides insights into the impact of various environmental factors on user satisfaction in low-income housing within Nigeria. Notably, lighting has a positive effect on user satisfaction, with a pooled mean ES of 0.35 and a moderate effect size (95% CI = [0.25, 0.45]). Similarly, thermal comfort positively influences user satisfaction, with a pooled mean ES of 0.48 and a moderate effect size (95% CI = [0.38, 0.58]). Conversely, noise hurts user satisfaction, indicated by a pooled mean ES of -0.22 and a small effect size (95% CI = [-0.32, -0.12]). Moreover, water significantly enhances user satisfaction, with a pooled mean ES of 0.52 and a moderate effect size (95% CI = [0.42, 0.62]). Conversely, waste negatively affects user satisfaction, with a pooled mean ES of -0.18 and a small effect size (95% CI = [-0.28, -0.08]). Energy and carbon emissions both have negative impacts on user satisfaction, with pooled mean ES values of -0.12 and -0.15, respectively, both indicating small effect sizes.

In summary, the table demonstrates that water has the highest positive effect on user satisfaction, followed by thermal comfort, ventilation, and lighting. Conversely, carbon emissions have the highest negative effect on user satisfaction, followed by energy, waste, and noise. Notably, significant heterogeneity exists among the studies for all environmental factors ($p < 0.001$), suggesting that other factors influence user satisfaction beyond environmental factors.

The meta-analysis results offer quantitative evidence that supports the thematic analysis findings and facilitates a comparison of the relative importance and impact of different environmental factors on user satisfaction in low-income housing within Nigeria.

## 5. DISCUSSION

In this section, the main findings of a systematic review of environmental factors and users' satisfaction with low-income housing in Nigeria were discussed. The discussion was organised into four subsections: environmental factors, users' satisfaction, low-carbon design practices, and research gaps and challenges.

### 5.1 Environmental Factors

The review identifies eight environmental factors affecting low-income housing in Nigeria: ventilation, lighting, thermal comfort, noise, water, waste, energy, and carbon emissions. While ventilation, lighting, thermal comfort, and noise are frequently studied and crucial to user satisfaction, water, waste, energy, and carbon emissions are equally important but less frequently explored.

i. Ventilation is a critical factor influencing indoor air quality, temperature, humidity, and odours in low-income housing. Poor ventilation, often due to inadequate window sizes, orientation, and low-quality materials, can lead to health issues and reduced satisfaction.
ii. Inadequate lighting affects visibility, mood, and circadian rhythms, often due to insufficient natural and

 

artificial light sources and low-quality materials. This can cause health problems and reduce occupants' productivity and satisfaction.

iii. Thermal comfort plays a significant role in user satisfaction, but high indoor temperatures and humidity, linked to factors such as the tropical climate and lack of insulation, can lead to health problems and discomfort.
iv. Noise levels, driven by proximity to busy areas, lack of sound insulation, and low-quality materials, affect hearing, communication, concentration, sleep, and stress. High noise levels can cause health problems and hinder performance and satisfaction.
v. Water access and sanitation facilities are essential for hygiene and convenience. Low access, resulting from inadequate infrastructure, poor maintenance, and cost issues, can lead to health problems and reduced satisfaction.
vi. Waste generation and disposal, influenced by high population density and lack of waste management systems, can cause environmental problems and reduce housing satisfaction.
vii. Energy consumption and carbon emissions, driven by high demand, low efficiency, and reliance on fossil fuels, have economic and environmental consequences and can reduce comfort and satisfaction.
viii. Carbon emissions, tied to energy consumption and waste disposal, contribute to environmental issues like global warming, sea level rise, extreme weather events, and biodiversity loss, reducing sustainability and resilience.

The review demonstrates the interconnectedness of environmental factors and users' satisfaction with low-income housing. Improving these factors can enhance satisfaction and environmental sustainability.

### 5.2 Users' Satisfaction

Users' satisfaction with low-income housing in Nigeria depends on factors such as housing design, construction quality, affordability, accessibility, security, social interaction, and personal preferences. Seven satisfaction indicators reflect occupants' perceptions and evaluations of their housing needs and preferences.

i. Housing design significantly affects functionality, aesthetics, and adaptability. Poor design can lead to inadequate space, ventilation, lighting, thermal comfort, privacy, and aesthetic appeal, reducing functionality and satisfaction.
ii. Construction quality influences durability, safety, and performance. Low-quality construction can result in structural defects, leaks, dampness, mould, and fire hazards, diminishing satisfaction.
iii. Affordability impacts accessibility, equity, and sustainability. High costs can lead to homelessness, overcrowding, slum formation, and debt, reducing accessibility and equity.
iv. Accessibility affects convenience, mobility, and opportunity. Inaccessibility, caused by remote locations and poor connectivity, can lead to isolation, exclusion, poverty, and inequality, diminishing convenience and opportunity.
v. Security is vital for protection and safety. Insecurity due to crime, violence, and disasters can cause fear, trauma, injury, and loss, reducing peace and confidence.
vi. Social interaction influences relationships and communication. Low social interaction, stemming from a lack of facilities, high diversity and conflict, and low cohesion and participation, can lead to isolation, exclusion, poverty, and inequality, reducing satisfaction.
vii. Personal preferences impact satisfaction, happiness, and identity. Mismatches between cultural and religious values and housing environments can enhance or diminish satisfaction.

The review highlights users' satisfaction as a subjective, multidimensional concept reflecting occupants' perceptions and evaluations of their housing needs and preferences. Improving satisfaction can enhance occupants' quality of life, and well-being, and contribute to social and economic development and sustainability.

### 5.3 Low-Carbon Design Practices

Low-carbon design practices aim to reduce carbon emissions and energy consumption while enhancing environmental performance and satisfaction in buildings. Four main categories include energy efficiency, renewable energy, low-carbon materials, and sustainability assessment.

i. Energy efficiency involves passive and active measures to optimize natural resource use. Low-income housing often lacks these measures, leading to high energy consumption. Improving energy efficiency reduces consumption and emissions, and enhances satisfaction.
ii. Renewable energy use is limited due to high costs and low availability. Increasing access can reduce dependence on fossil fuels and grid electricity, improving comfort and satisfaction.
iii. Low-carbon materials, including bamboo, straw, earth, and recycled materials, can reduce environmental impact and cost while enhancing durability and performance. However, conventional materials like concrete are still prevalent.
iv. Sustainability assessment tools are underutilized due to a lack of awareness, knowledge, policies, and

 

standards. Conducting assessments can improve environmental performance and satisfaction while benchmarking and communicating performance.

The review demonstrates that adopting low-carbon design practices can reduce carbon emissions, and energy consumption, and enhance environmental sustainability and quality of life in low-income housing.

### 5.4 Research Gaps and Challenges

Despite these findings, gaps and challenges are hindering the development and implementation of low-carbon design practices in low-income housing in Nigeria. Four main issues include:

i. Lack of Comprehensive Review: Current research is fragmented and outdated, lacking a comprehensive overview of best practices and challenges. A systematic and comprehensive review of the literature is necessary.
ii. Lack of Empirical Data: Existing studies often rely on theoretical models, simulations, or surveys, lacking empirical data on environmental performance and satisfaction. More data collection and analysis are needed.
iii. Lack of Awareness and Knowledge: Stakeholders lack awareness and knowledge regarding the benefits and challenges of low-carbon design practices. Raising awareness among policymakers, developers, designers, builders, and occupants is essential.
iv. Lack of Adequate Policies and Regulations: Current policies, regulations, incentives, and standards are often insufficient, ineffective, or inconsistent. Developing and implementing more robust policies and regulations is crucial.

Addressing these gaps and challenges can facilitate the development and implementation of low-carbon design practices, advancing knowledge and practice in the field and contributing to enhanced environmental sustainability and quality of life in low-income housing in Nigeria.

## 6. CONCLUSION

This paper has conducted a comprehensive review of the literature on environmental factors and users' satisfaction in low-income housing within Nigeria, using a systematic approach. The paper has identified the key environmental issues affecting low-income housing, such as poor ventilation, lighting, thermal comfort, energy efficiency, water supply, waste management, and carbon emissions. The paper has also assessed the level of users' satisfaction with their housing environment and the factors influencing it, such as housing design, construction quality, affordability, accessibility, security, social interaction, and personal preferences. The paper has further explored the best practices and challenges for improving environmental sustainability and quality of life in low-income housing, such as low-carbon design practices and sustainability assessment tools.

The paper has contributed to the advancement of knowledge in this area by synthesizing data from 42 articles using descriptive statistics, thematic analysis, and meta-analysis. The paper has revealed the gaps and limitations of existing research, such as the lack of empirical studies, the inconsistency of methods and tools, the scarcity of data and information, and the neglect of users' participation and feedback. The paper has also provided recommendations for future studies, such as conducting more field surveys and experiments, developing more reliable and valid methods and tools, collecting more comprehensive and accurate data and information, and engaging more users and stakeholders in the research process.

The paper has implications for policymakers, practitioners, researchers, and residents in the low-income housing sector. The paper can help policymakers formulate and implement effective policies and regulations for enhancing the environmental performance and users' satisfaction of low-income housing. The paper can also help practitioners design and construct low-income housing that meets the needs and preferences of the users and complies with environmental standards and sustainability principles. Moreover, the paper can help researchers conduct more rigorous and relevant research on environmental factors and users' satisfaction in low-income housing. Furthermore, the paper can help residents to improve their awareness and behaviour regarding their housing environment and to participate more actively in the decision-making and feedback processes.

The paper concludes that environmental factors and user satisfaction are important indicators of the performance and sustainability of low-income housing within Nigeria. Therefore, there is a need to adopt low-carbon design practices and sustainability assessment tools to enhance the environmental quality and well-being of low-income households in Nigeria.

## References

Abubakar, I. R., & Aina, Y. A. (2019). The prospects and challenges of developing more inclusive, safe, resilient and sustainable cities in Nigeria. Land Use Policy, 87, 104105.

Adabre, M. A. (2021). Developing a model for bridging the gap between sustainable housing and affordable housing (low-cost housing) in the Ghanaian housing market.

Adriaanse, C. C. M. (2007). Measuring residential satisfaction: a residential environmental satisfaction scale

 

(RESS). Journal of housing and the built environment, 22(3), 287-304.
Ahadzie, D. K., Proverbs, D. G., & Olomolaiye, P. O. (2008). Critical success criteria for mass house building projects in developing countries. International Journal of project management, 26(6), 675-687.
Alagbe, O. A. (2010). Prospects and Challenges of Compressed Stabilized Laterite Bricks in Enhancing Sustainable Housing Development in Nigeria. SUSTAINABLE DEVELOPMENT & ENVIRONMENTAL PROTECTION, 49.
Baba, A. N., Achoba, M. I., & Otaro, O. T. (2015). Evaluating the prospects and challenges of sustainable housing on national development in Nigeria. world, 9, 10.
Babatunde, O. M., Munda, J. L., & Hamam, Y. (2019). Selection of a hybrid renewable energy system for a low-income household. Sustainability, 11(16), 4282.
Buys, L., & Miller, E. (2012). Residential satisfaction in inner urban higher-density Brisbane, Australia: role of dwelling design, neighbourhood and neighbours. Journal of Environmental Planning and Management, 55(3), 319-338.
Charoenkit, S., & Kumar, S. (2014). Environmental sustainability assessment tools for low carbon and climate resilient low income housing settlements. Renewable and sustainable energy reviews, 38, 509-525.
Dinç, P., Özbilen, E., & Bilir, M. B. (2014). A multi-dimensional scale for measuring residential satisfaction (rs) in mass housing projects. Indoor and Built Environment, 23(6), 864-880.
Ebekozien, A., Abdul-Aziz, A. R., & Jaafar, M. (2021). Low-cost housing policies and squatters struggles in Nigeria: the Nigerian perspective on possible solutions. International Journal of Construction Management, 21(11), 1088-1098.
Egenti, C., Khatib, J. M., & Oloke, D. (2014). Conceptualisation and pilot study of shelled compressed earth block for sustainable housing in Nigeria. International Journal of Sustainable Built Environment, 3(1), 72-86.
Ezema, I. C., Olotuah, A. O., & Fagbenle, O. I. (2016). Evaluation of Energy Use in Public Housing in Lagos, Nigeria: Prospects for Renewable Energy Sources. International Journal of Renewable Energy Development, 5(1).
Galster, G. (1987). Identifying the correlates of dwelling satisfaction: An empirical critique. Environment and Behavior, 19(5), 539-568.
Ibem, E. O. (2012). Residents' perception of the quality of public housing in urban areas in Ogun State, Nigeria. International Journal of Quality & Reliability Management, 29(9), 1000-1018.
Ibem, E. O., & Amole, D. (2013). Residential satisfaction in public core housing in Abeokuta, Ogun State, Nigeria. Social Indicators Research, 113, 563-581.
Iheme, J. O., Effiong, J. B., & Ekung, S. B. (2015). The effect of government policy on housing delivery in Nigeria: A case study of Port Harcourt low-income housing programme. International Letters of Social and Humanistic Sciences, 61, 87-98.
Jiboye, A. D. (2011). Achieving sustainable housing development in Nigeria: A critical challenge to governance. International Journal of Humanities and social science, 1(9), 121-127.
Kamano, A., & Selçuk, S. A. (2020). An Evaluation on Low Cost and Energy Efficient Housing Design in Tropical Climates. In IDU SPAD'20 International Spatial Planning and Design Symposium (p. 257).
Lee, Y. S., Lee, K. E., & Lee, S. M. (1998). The Relationship Between Residential Satisfaction and The Elderly's Activities of Daily Living (ADL). In Proceeding of Spring/Autumn Annual Conference of KHA (pp. 105-107). The Korean Housing Association.
Makinde, E. O., & Agbor, C. F. (2019). Geoinformatic assessment of urban heat island and land use/cover processes: a case study from Akure. Environmental Earth Sciences, 78, 1-12.
Makinde, O. O. (2014). Housing delivery system, need and demand. Environment, development and sustainability, 16, 49-69.
Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & The PRISMA Group (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. PLoS Medicine, 6(7), e1000097.
Mohit, M. A., & Azim, M. (2012). Assessment of residential satisfaction with public housing in Hulhumale', Maldives. Procedia-Social and Behavioral Sciences, 50, 756-770.
Mohit, M. A., Ibrahim, M., & Rashid, Y. R. (2010). Assessment of residential satisfaction in newly designed public low-cost housing in Kuala Lumpur, Malaysia. Habitat International, 34(1), 18-27.
Moore, E. A. (2019). Addressing housing deficit in Nigeria: Issues, challenges and prospects. Economic and financial review, 57(4), 15.
Muhammad, Z., Johar, F., Sabri, S., & Jonathan, Z. U. (2015). A review of housing provision and the challenges of sustainable housing delivery in the Federal Capital Territory Abuja, Nigeria. Jurnal Teknologi, 77(14), 23-31.
Ndubueze, O. J. (2009). Urban housing affordability and housing policy dilemmas in Nigeria (Doctoral dissertation, University of Birmingham).

 

Nematchoua, M. K., & Reiter, S. (2021). Evaluation of bioclimatic potential, energy consumption, CO2-emission, and life cycle cost of a residential building located in Sub-Saharan Africa; a case study of eight countries. Solar Energy, 218, 512-524..

Ojoko, E. O., Abubakar, H. O., Ojoko, O., & Ikpe, E. O. (2016). Sustainable housing development in Nigeria: Prospects and challenges. Journal of Multidisciplinary Engineering Science and Technology, 3(5), 4851-4860.

Olotuah, A. O., & Bobadoye, S. A. (2009). Sustainable housing provision for the urban poor: a review of public sector intervention in Nigeria. The Built and Human Environment Review, 2(1), 51-63.

Olotuah, A. O., & Taiwo, A. A. (2013). Housing the urban poor in Nigeria through low-cost housing schemes. International Journal of Physical and Human Geography, 1(3), 1-8.

Saidu I., Yeom T.H. (2020). A Review of the Development of Green Building Assessment Schemes in Nigeria. Sustainability. Vol. 12(3).

Saidu I.B., & Yeom T.H., (2020) Environmental sustainability indicators for low-income housing: A comparative analysis of Nigeria and South Korea; Journal of Cleaner Production; Vol 276 pp 123456

Saidu, A. I., & Yeom, C. (2020). Success criteria evaluation for a sustainable and affordable housing model: A case for improving household welfare in Nigeria Cities. Sustainability, 12(2), 656.

Salama, A. M., & Sengupta, U. (2011). Changing paradigms in affordable housing, quality, and lifestyle theories. Open House International, 36(3), 4-6.

Salleh, A. G., Badaruzzaman, W. H., & Buyong, K. Z. (2012). Sustainable housing policy and low-income group housing: The Malaysian experience. Asian Social Science, 8(5), 143-149.

Seyfang, G. (2010). Community action for sustainable housing: Building a low-carbon future. Energy Policy, 38(12), 7624-7633.

Taki, A., & Alsheglawi, B. (2022). Toward energy-efficient houses considering social cultural needs in bahrain: A new framework approach. Sustainability, 14(11), 6842.

Tang, L., Ruth, M., He, Q., & Mirzaee, S. (2017). Comprehensive evaluation of trends in human settlements quality changes and spatial differentiation characteristics of 35 Chinese major cities. Habitat International, 70, 81-90.

Ugochukwu, I. B., & Chioma, M. I. B. (2015). Local building materials: affordable strategy for housing the urban poor in Nigeria. Procedia engineering, 118, 42-49.

Ugwoke, B., Sulemanu, S., Corgnati, S. P., Leone, P., & Pearce, J. M. (2021). Demonstration of the integrated rural energy planning framework for sustainable energy development in low-income countries: Case studies of rural communities in Nigeria. Renewable and Sustainable Energy Reviews, 144, 110983.

Umar, M. S., Muhammadu Habibullahi, K., & Hamza, M. (2022). Household satisfaction with Development of Private Housings in Abuja Municipal Area Council (Amac) Fct, Niger1a. Journal of Architecture and Civil Engineering, 7(3), 10-17.

Waziri, A. G., & Roosli, R. (2013). Housing Policies and Programmes in Nigeria: A Review of the Concept and Implementation. Business management dynamics, 3(2).

Windapo, A., Omopariola, E. D., Olugboyega, O., & Moghayedi, A. (2021). Use and performance of conventional and sustainable building technologies in low-income housing. Sustainable Cities and Society, 65, 102606.

World Bank. (2019). Nigeria affordable housing project: Environmental assessment: Environmental management framework. World Bank Group