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Bridging Research and Practice in Sustainable Housing for Low-income Earners: A Systematic and Meta-Analytic Synthesis

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Abstract

Efforts to secure sustainable housing for low-income earners constitute a persistent challenge in addressing housing deficits, particularly in developing economies. This study systematically examined the current state of research on sustainable housing for low-income communities, identified gaps, and proposed innovative implementation strategies and comprehensive frameworks. The mixed-methods approach (a systematic literature review (SLR) and meta-analysis) was implemented, and the study was conducted according to PRISMA guidelines with the PICOS framework being followed to provide rigor and transparency. The review summarized evidence from 48 peer-reviewed articles published between 2000-2024. Key findings were categorized into six thematic areas: challenges to sustainable housing, innovative strategies, energy efficiency, indoor environmental quality, sustainable building materials, and the development of comprehensive frameworks. The governance related barriers, the high initial cost of renewable energy technologies and lack of lifecycle assessment of sustainable building materials were noted as major barriers. The use of public-private partnerships, modular construction, and use of locally available materials proved to show significant potential in increasing sustainable housing provision. This study contributes to literature by consolidating fragmented research and highlighting gaps in empirical findings. The originality of this work lies in its dual methodology, which combines systematic review with meta-analysis to provide a robust and holistic understanding of the factors influencing sustainable housing.

Keywords: Housing affordability, low-income earners, meta-analysis, sustainable housing, sustainable building materials, systematic literature review.

Introduction

Globally the need to build sustainable housing has intensified in recent time, alongside with the accelerating urbanisation and the exigencies of climate change. The realization of Sustainable Development Goal 11 (SDG-11) is based on the capacity to offer housing that do not harm the environment but promote both social and economic benefits. This highlights the importance of sustainable housing, nevertheless, sustainable housing may not be easily implemented uniformly across every geographic and cultural context (Ebekozien et al., 2025). This is because of the challenges that comes with sustainability implementation (Gao, 2025); hence, scholars have advocated for context-specific implementation that is informed by a user-centred perspective that reflects local ecologies, residents' needs, and their preferences (Ajayi et al., 2024; Ebekozien et al., 2025).

The concept of sustainable housing according to Nubi and Afe (2014) emerges from the idea of sustainable development. Hence, sustainable housing concept encompasses social, economic and environmental pillars. Muhammad, Johar

and Sabri (2015) stressed that social pillar in housing development entails the provision of shelter and protection for the inhabitants, economic pillar offers a good investment with tangible returns, while environmental pillar delivers reduce greenhouse gas emission, optimize energy usage and material and improve waste management. Prioritizing the three pillars in sustainable housing aims at ensuring that current generation housing solutions does not in any way deprive the future generations of their rights to appropriate shelter. It underlines the construction of homes that are accessible, affordable, rewarding, sustainable and that are for all people. Chiu (2006) describes sustainable housing as one that has low energy demand and minimal carbon footprint and at the same time integrates the community and socially sustainable aspects. Modern and developed countries like Germany, Sweden, and the United States have adopted endeavours such as passive standards and green building endorsing to enhance sustainable housing (Feist, 2018). Kheni and Adzraku, (2022) opined that sustainable housing entails the incorporation of cost-effective designs that have been developed to be friendly to the pocket of the low coming income earners through consumption of little energy. In environmental perspective, it responds to some of the environmental issues such as expansion of urban area, deforestation and greenhouse gas emission through use of green building materials and energy sources (Gan et al., 2017). It emphasizes improved indoor quality that reduces health hazards leading to a higher quality of life (Piroozfar et al., 2012).

Sustainable housing remains fundamental to drive social equity, economic stability, and environmental stewardship, especially in developing economies where housing deficits deepen existing inequalities. The low-income earners that usually constitute a high percentage of the population have a difficult time, due to the lack of finances, weak policy enforcement, and the limited accessibility to quality building materials (Akinsulire et al., 2024; Olubi & Aseyan, 2021, Kheni & Adzraku, 2022). Like every other developing economy, these crises are most strongly felt by low-income populations in Nigeria, where the housing shortage has increased to 28 million units in 2023 (Nesgroup, 2024). Even though global research keeps introducing sustainable housing innovations, putting them into practice and tailoring them to local realities is still in its early stages in many developing economies. Sustainable housing is ensuring that housing provision satisfies the demands of the users, the environment and the developers. It is tied to the social, environmental, and economic metrics of the housing development process, as it addresses the housing affordability, energy efficiency, environmental protection, and cultural appropriateness (Oyetunji et al., 2022). However, scholars have shared that the implementation of sustainable housing, especially in developing economies comes with its unique challenges (Akinsulire et al., 2024; Tynkkynen et al., 2025), despite acknowledging its immediate usefulness.

In Nigeria, the concept of sustainable housing is still a big issue because of the increasing rate of urbanization, population, and the limitation of funds. Challenges to the construction of sustainable housing in Nigeria are numerous, these include; high cost of materials, lack of skilled workforce, and weak policies. This implies that developed building materials like concrete and steel alone are costly and also unsustainable at the same time pushing for the usage of developed sustainable building materials like compressed earth block and bamboo composite among others, but now they are rarely used (Olotuah & Adesiji, 2020). The low-income earners are a large group in the society and are locked out of formal housing markets by high costs and limited access to credit (Adedeji & Salman, 2023). There is a growing population of squatters with limited or no access to sanitation and other amenities, which is now a growing environmental concern in several parts of Nigeria (Ogundipe et al., 2024). These are compounded by climate change effects which cause floods and heat waves and which compromise the stability and liveability of housing structures (Haruna et al., 2023). These realities strengthen the need for the current study. While sustainability in housing is not a new concept, its broad application in several developing economies remains constrained. Addressing these challenges requires targeted efforts to

understand the current state of research in the field, which is the central aim of this study.

While the current state of literature has made sufficient effort to identify and address these challenges (Adedeji et al., 2023; Olubi & Aseyan, 2021), the available framework is still disjointed, as it has failed to capture the regional and cultural peculiarities in a structural manner that will aid implementation. Hence, supporting the need for this study. Further, in-depth x-ray of extant literature showed that tailored specific sustainable housing solutions to low-income earners in the developing economies remains has not been sufficiently addressed. Most research is on urban, high-tech or capital-intensive solutions that do not necessarily apply in resource-limited locations (Mehmood et al., 2024; Obianyo et al., 2021; Taylor & Howden-Chapman, 2021). Hence, explaining the growing advocacy around research on sustainable building material and renewable energy systems for low-income housing. However, scholarly response still lacks specific direction, and this could be because of the absence of sufficient studies that have highlighted the current state of literature that would guide future research agenda. This disconnects in research could explain the weak practical implementation, which further underscores the need for a comprehensive synthesis of extant literature that will guide evidence-based decisions regarding sustainable housing for low-income earners. Further, the current literature shows the presence of fragmented and inconsistent nature of existing studies on sustainable housing, as the studies are dispersed across varying fields, with weak cross-referencing and scarce integration attempts.

Against this backdrop, the study postulated the following research questions, and they include: What is the geographical distribution of research on sustainable housing, and which countries are leading or lagging in contributions? What are the predominant document types in the body of sustainable housing literature for low income-earners? What research methodologies are most used in sustainable housing for low-income earners studies? What are the most common overarching themes and sub-themes in sustainable housing research? The research fills this gap by applying the systematic review and meta-analysis approach, which results in an understandable and clear synthesis of scattered evidence, allowing identifying patterns, trends, and gaps. The meta-analysis augments the systematic literature review study by quantifying the effects of varied factors on sustainable housing outcomes, thereby supplying empirical evidence to complement the qualitative insights that emerged. This study integrates findings from diverse strands of research, thereby furnishing a holistic understanding of the challenges and opportunities associated with sustainable housing for low-income earners. Second, it establishes gaps in the current knowledge and makes recommendations on future research and policy formulation. Lastly, the research contextualizes a critical and objective review of the literature, which offers sound findings that are generalizable and context-specific. The central question that guided this review was: "What is the current state of research on sustainable housing for low-income earners, and how can the identified gaps be addressed to advance sustainable housing solutions?"

Methodology

Research Process

The research process is captured in the flowchart indicated in Fig. 1. It reflects the step–by-step process in conducting the study.

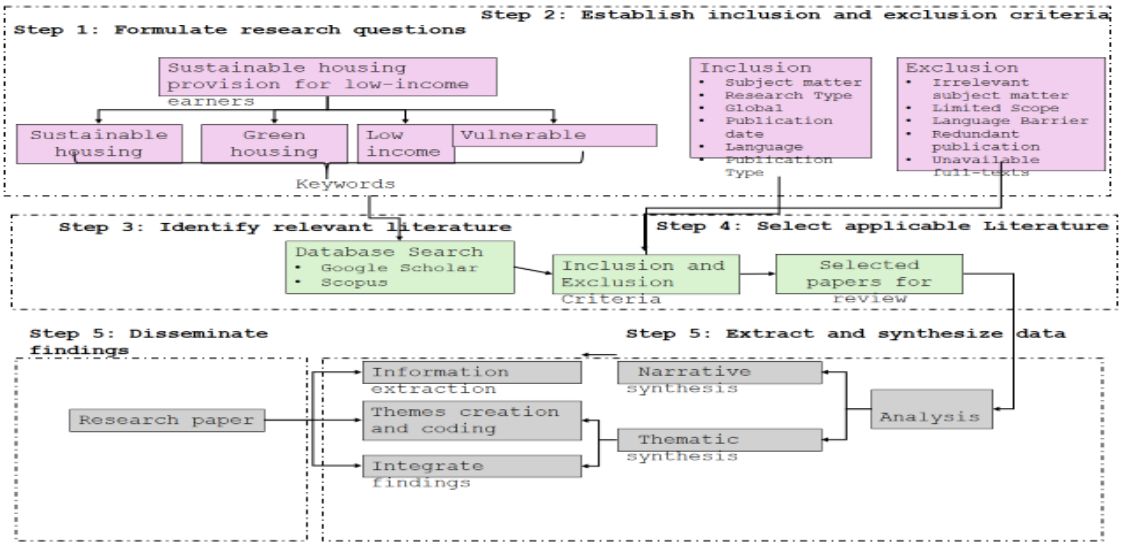

Figure 1: Research Process

The study used a mixed-method design which was a combination of systematic literature review (SLR) and meta-analysis. The SLR provided qualitative evidence and emphasized the common thematic trends, while the meta-analysis united the works that reported similar metrics at the quantitative level, thus, providing strong statistical grounds to the study findings. This study adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework (Page et al., 2021), thus making it rigorous, transparent, and reproducible.

PICOS framework (Population, Intervention, Comparison, Outcome, and Study design) was used to frame the inclusion and exclusion criteria (Higgins et al., 2020). This is because the framework ensures systematic evaluation of studies against the review objectives. One major inclusion criterion was ensuring the studies specifically focused on sustainable housing for low-income earners. We used the PICOS model (Population, Intervention, Comparison, Outcome, and Study design), which allowed for applying the necessary structure to develop both inclusion and exclusion criteria (Higgins et al., 2020). The major inclusion criterion was the requirement that the studies address sustainable housing initiatives aimed at supporting low-income earners

Table 1: Criteria for Inclusion and Exclusion for SLR study

Criteria	Inclusion	Exclusion
Study population	Sustainable housing for low-income earners	Sustainable housing for mid/high-income earners
Study type	Peer reviewed articles, proceedings, book chapters	Technical reports, editorials etc
Language	Publication written in English Language	Publications written non-english language eg French, Russian etc
Publication Date	Studies undertaken to between 2000-2024	Studies undertaken before 2000

Geographic scope	Global

Also, studies that assessed varying sustainable housing strategies or frameworks were included and this was to provide an understanding of the effectiveness and contextual relevance of different sustainable housing frameworks. Qualitative, empirical and mixed method studies that put into consideration practical applications and challenges, best practices that can inform policy making and professional practice were also included. Studies published in peer-reviewed and reputable journals and conference proceedings were included and the study year scope was studies published from 2000 to 2024 and written in English language. The study excluded a number of studies based on a number of criteria. Studies that focused on high-income housing were omitted, since those spheres fail to consider the specific needs and problems that face low-income earners. Studies in non-English languages were also excluded and this study did not consider opinion paper or web-based documents.

The review methodology was based on a thorough and iteratively detailed search strategy. Table 2 highlighted that searches were executed across the Scopus and Google Scholar electronic databases, and Boolean operators were applied to construct search terms, such as “Sustainable housing” OR "green housing" OR "sustainable affordable housing" OR "eco-friendly housing") AND ("low-income" OR "informal settlement" OR "vulnerable population" OR "urban poor"). The first screening led to identifying 1,245 studies from which duplicates were removed. A study of titles and abstracts identified 245 potentially eligible articles, after which 48 studies met all PICOS criteria. The reviewers, i.e. the authors of this study, resolved their disagreements by discussion (Page et al., 2021).

Table 2: Sample Document Search Log

Database name	Search Terms used	Date of Search	Number of Results	Total Document Used
Scopus and Google Scholar	“Sustainable housing” OR "green housing" OR "sustainable affordable housing" OR "eco-friendly housing") AND ("low-income" OR "informal settlement" OR "vulnerable population" OR "urban poor")	July 2025	1,245	48

Source: Authors’ compilation, 2025

A structured data extraction template was used to ensure that the necessary attributes of the studies could be identified. The extraction template was piloted on a smaller number of studies to guarantee consistency and reliability based on the standards presented by Arksey and O’Malley (2005).

The synthesis only included the studies that achieved the minimum quality standard (Singh, 2013). Thematic analysis was used to synthesise data to determine the patterns within qualitative datasets (Braun & Clarke, 2006). The coding and organising themes were carried out with the aid of NVivo 11 software. In the meta-analysis, the statistically similar quantitative data studies were combined statistically by means of random-effects models. The effect sizes and heterogeneity were also estimated to determine the level of consistency of various findings (Borenstein et

al., 2009). The meta-analysis provided aggregate insights into the effectiveness of sustainable housing interventions, complementing the thematic synthesis.

Results and Discussions

A total of 48 peer-reviewed articles were identified, analysed and included in the review with the publication period of 2000-2024. The selected studies satisfied the study inclusion criteria before they were used for analysis. The Figures 2-5 provide the visual representation of the nature of the studies included. Table 3 presents a tabularizing overview of the identified themes, sub-themes and sources. The geographic diversity of the studies and methodological approaches underscores the global relevance and varied perspectives on sustainable housing.

Geographical distribution of research on sustainable housing for low-income earners

Figure 2 revealed frequency distribution of research carried out relating to sustainable housing for low-income earners globally. The studies reviewed were predominantly from developing economies, accounting for 72.9% of the total, while developed economies contributed 27.1%. This highlights the focus on addressing housing challenges in resource-constrained contexts, with Nigeria and Malaysia leading the representation among developing countries.

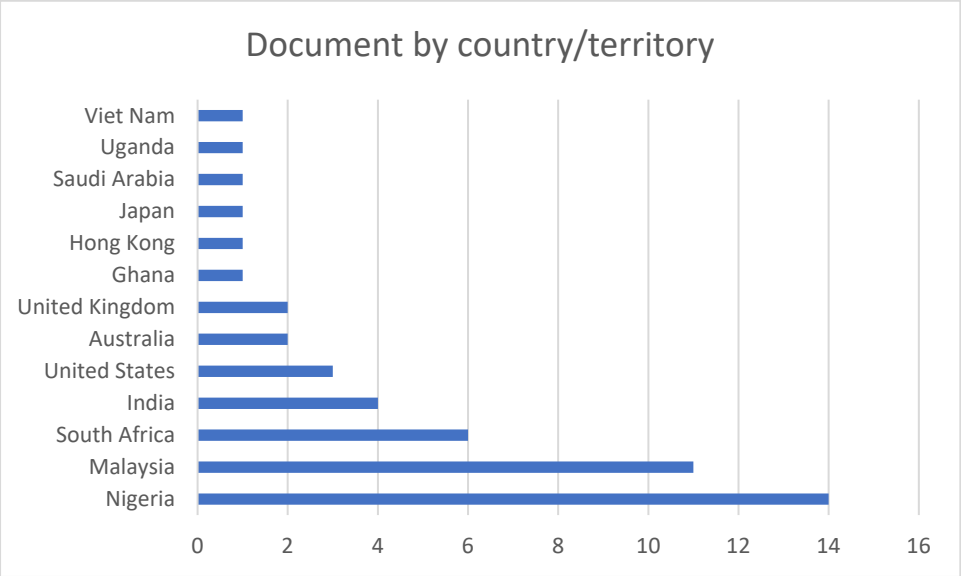

Figure 2: Reviews country
Source: Authors' compilation, 2025

Figure 2 revealed that studies on the subject matter from Nigeria and Malaysia presents a strong local research capacity that generate publications. Research from Africa is comparatively well represented especially on affordability, delivery systems and service provision. While Asia's picture on sustainable housing provision is uneven, Malaysia drives most of Asia's count; India appears in the count but is smaller than expected. There are relatively few studies from developed countries such as Australia, US, UK. This is because the study scope is low-income housing whereas developed nations' context is domiciled in retrofitting, weatherization or social housing decarbonization literature. These concepts are not indexed under 'low-income housing" keywords.

Table 3: Housing provision for low-income earners in selected countries between 2021-2023

Country	Average Number of Units/ years	Source
Nigeria	4,800	Richards (2025)
South Africa	35,931	Department of Human Settlements (2021, 2022, 2023)
United Kingdom	71,604	DLUHC (2021, 2023)

United States	78, 388	U.S. Department of Housing and Urban Development (2024)
Malaysia	5,045*	The Star (2023)
India	5,801,918	Press Information Bureau, (2023), Lok Sabha Secretariat, (2025)
Ghana	1, 586	National Development Planning Commission (2022)
Vietnam	13, 864**	Tuổi Trẻ Online (2024)

*data for only affordable housing target by Government in 2023
** Government information available for 2023 only

Table 3 indicated the average number of low-income/affordable units delivered per year (2021–2023 window) for selected countries, using each country's best official proxy for "low-income housing." India dominates the housing provision scale with approx. 5.8million units/year driven by federal government programme. South Africa, US and United Kingdom are classified as mid-tier producers between 35,000-79,000 units/year. Other countries including Malaysia, Nigeria, Ghana and Vietnam have low volume of housing provision per year for low-income earners with about 4,250, 4,800, 1,586 and 13,864 respectively. From the results, it is evident that despite the high research output on sustainable housing for low-income earners in Nigeria, there is little or no impact made on housing provision to these marginalized people within the country. It can thus be inferred that majority of the researches are not applicable to the perculiar needs of low income citizens of the country In sharp contrast, India has little output but there is strong housing provision delivery within its boundaries for low-income earners. The same applies to other developed nations such as UK, USA, and South Africa to mention but a few.

The chart in Figure 3 depicted the comparison of the number of output per countries and the housing deficit. It is evidenced in Fig. 1 that most of the countries data on document output compared to housing deficit is insignificant, but India result shows that the country housing deficit is far more than the country's document output.

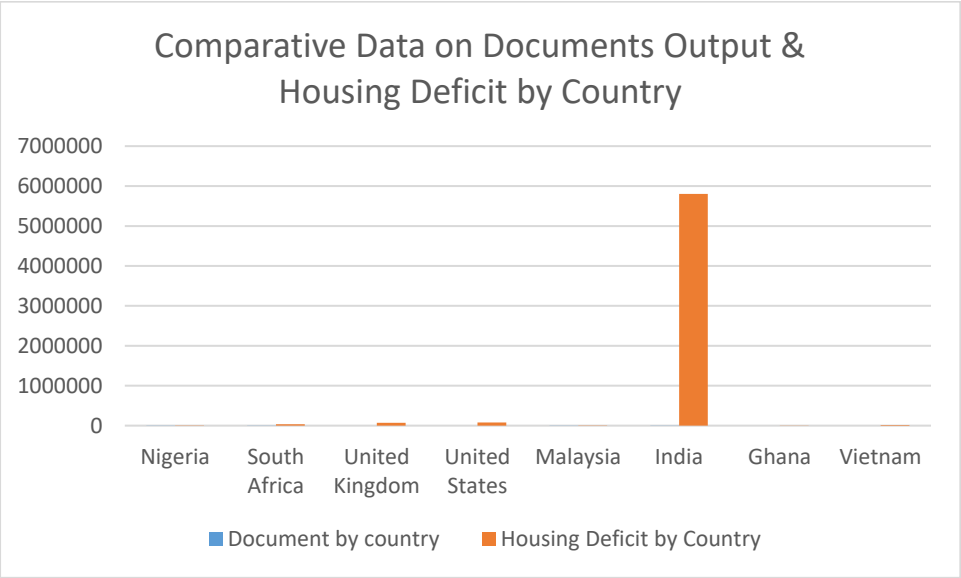

Figure 3: Country's Data Comparison on Documents Output and Housing Deficit.
Source: Authors' compilation, 2025

Predominant document types in the body of sustainable housing literature for low income-earners

This section highlights the frequency distribution of the different document types in the body of knowledge of sustainable housing literature for low-income earners. Many of the studies were journal articles, comprising 68.8%, followed by conference papers (18.8%), book chapters (10.4%), and reviews (2.1%). This distribution indicates a strong reliance on peer-reviewed literature to disseminate findings in the field of sustainable housing.

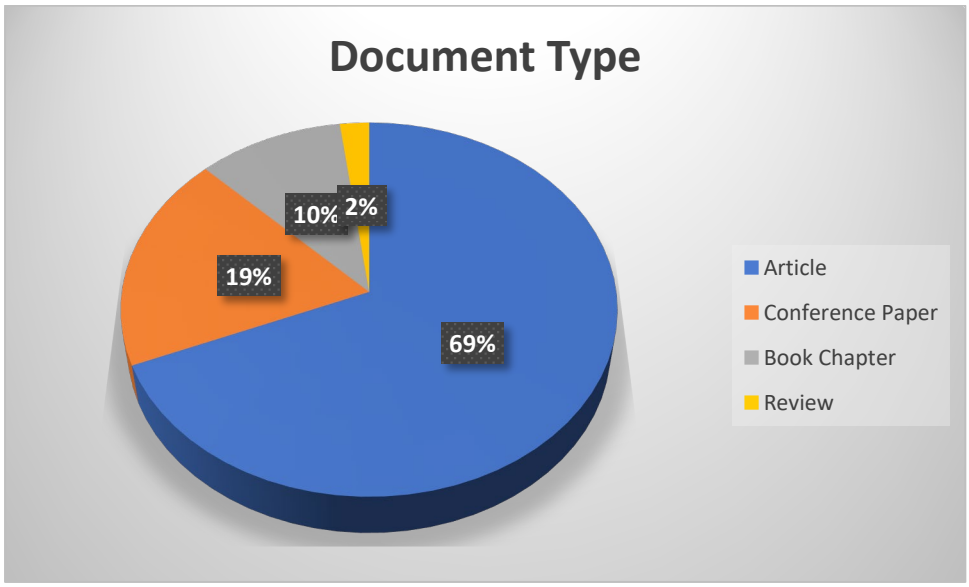

Figure 4: Document type
Source: Authors' compilation, 2025

The high proportion of articles as a document type presents a backbone for quantitative synthesis. Another advantage to the high frequency of articles confirms the strength of the focus area, improving the odds of reproducible methods and extractable data (e.g. energy use, thermal comfort, best practices etc). The study is article-heavy (69%), which is ideal for meta-analysis, but the substantial minority (29%) of conferences/chapters signals that practice knowledge sits outside journals. In the same vein, book chapters are useful for theory or policy because of the element of rigor and data transparency. The limited number of review paper on the subject matter shows a fragmented and under-synthesized focus area.

Research methodologies used in studies for sustainable housing for low-income earners

This section provides the overview of research methodologies used in studies for sustainable housing for low-income earners. Qualitative methodologies dominated the studies, accounting for 60.4%, followed by quantitative approaches at 27.1%. Mixed-method studies made up 2.1%, while reviews represented 10.4%. The predominance of qualitative methods reflects the importance of understanding contextual and descriptive insights in sustainable housing research. This result underscores the need for cross-contextual studies that could inform how best practices from developed economies might be adapted to the unique challenges faced by developing countries.

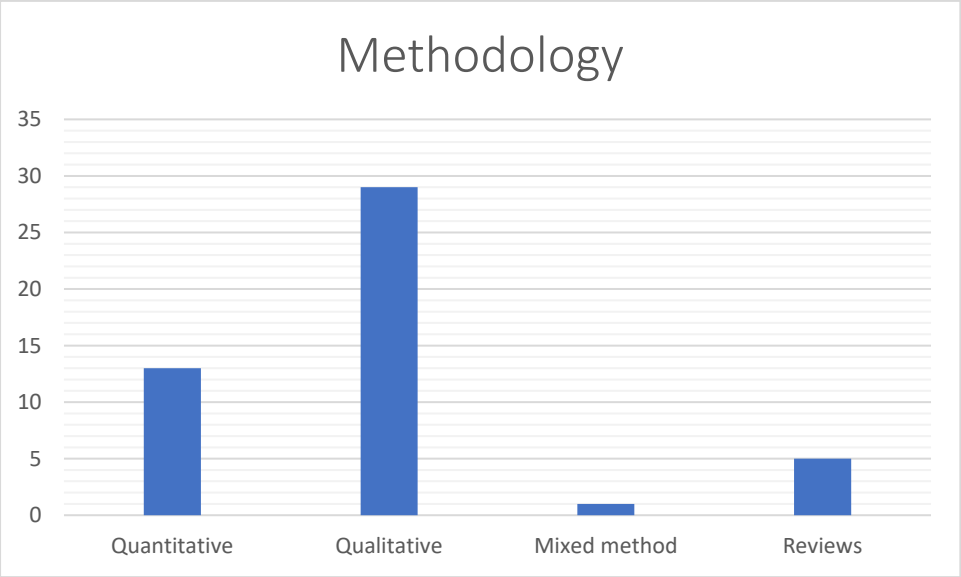

Figure 5: Reviews methodology
Source: Authors' compilation, 2025

Key Findings and Thematic Insights
The review highlighted limited exploration of cost-effective renewable energy technologies for low-income housing in rural areas. A lack of studies on the psychological and health impacts of poor indoor environments in low-income housing. Minimal focus on lifecycle assessments of sustainable materials, particularly in developing economies. It was also found that there are fragmented frameworks with inadequate emphasis on cultural and regional variations. These findings are discussed in the underlisted overarching themes.

Challenges to Sustainable Housing in Developing Economies
The review identified significant barriers, such as limited access to affordable financing, weak policy frameworks, socio-cultural constraints, and inadequate enforcement of building codes. These challenges resonate with broader issues of governance and economic disparities in developing regions. The lack of secure land tenure, cited in many studies, further exacerbates these challenges, making it difficult to implement scalable housing solutions. Addressing these issues requires not only policy innovation but also sustained political will and cross-sectoral collaboration.

Innovative Strategies for Sustainable Housing
The findings revealed a growing interest in public-private partnerships (PPPs), modular construction, and community-driven initiatives as viable strategies for sustainable housing. While these approaches show promise in cost reduction and scalability, the review noted a lack of empirical, mixed method and longitudinal studies that assess their long-term impact on affordability and sustainability. Integrating these strategies with local practices and resources could enhance their effectiveness and adaptability to specific contexts.

Table 4: Overarching themes, sub-themes, and sources

Theme	Sub-Themes	Sources

Challenges to Sustainable Housing	Limited access to affordable financing, weak policy frameworks, socio-cultural constraints, inadequate enforcement of building codes, lack of secure land tenure	Adedeji et al. (2023), Ajayi et al. (2016), Olubi & Aseyan (2021), Madawaki (2013), Ezennia (2022), Kheni & Adzraku (2022), Okereke & Okanya (2024)
Innovative Strategies for Sustainable Housing	Public-private partnerships (PPPs), modular construction, community-driven initiatives, integration with local practices and resources	Dania et al. (2021), Okereke & Okanya (2024), Umana et al. (2024), Moghayedi et al. (2023), Ezennia & Hoskara (2019), Ayo-Odifiri et al. (2022), Anusha et al. (2024), Ebekozien et al., (2023)
Energy Efficiency in Housing Provision	Renewable energy systems, passive cooling designs, subsidies or financing schemes for energy-efficient technologies	Ochedi & Taki (2022); Sapuan et al. (2022), Bataineh & Al Rabee (2022), Wesonga et al. (2023)
Indoor Environmental Quality	Poor ventilation, inadequate lighting, suboptimal thermal comfort, passive design strategies, lack of technical expertise	Saad et al. (2023); Ogunmola & Fadairo (2022); Felgueiras et al. (2023); Mewomo et al. (2023)
Sustainable Building Materials	Locally sourced materials (bamboo, recycled concrete, compressed earth blocks), challenges of standardization, durability, societal acceptance	Kennedy et al. (2021); Abera (2024); Bourbia et al. (2023); Masniari & Koestoer (2024), Ebekozien et al. (2023), Anusha et al. (2024)
Best-Practice Framework for Sustainable Housing	Lack of contextual adaptations, need for interdisciplinary approaches, combining technical guidelines with participatory processes	Habibullah et al. (2020); Mohammed et al. (2022); Turcotte & Geiser (2010); Ebekozien et al. (2024)

Source: Authors' compilation, 2025

Energy Efficiency in Housing Provision

Energy efficiency emerged as a crucial theme, with renewable energy systems like solar panels and passive cooling designs offering significant operational cost reductions for low-income households. However, the findings highlight the high initial costs of these technologies, which limit their widespread adoption. This underscores the need for policy interventions, such as subsidies or financing schemes, to make energy-efficient housing accessible to low-income earners.

Indoor Environmental Quality

The review revealed that poor ventilation, inadequate lighting, and suboptimal thermal comfort are persistent issues in low-income housing. These factors not only affect the well-being of residents but also undermine the sustainability of housing solutions. Passive design strategies, such as the strategic placement of windows and use of natural materials, were identified as effective measures. However, their implementation remains inconsistent due to a lack of technical expertise and awareness among stakeholders.

Sustainable Building Materials

The findings underscored the potential of locally sourced, eco-friendly materials, such as bamboo, recycled concrete, and compressed earth blocks, in reducing construction costs while ensuring environmental sustainability. Despite their promise, these materials face challenges related to standardization, durability, and societal acceptance. Further

research and awareness campaigns are needed to encourage their adoption at scale.

Best-Practice Framework for Sustainable Housing

Few studies have developed comprehensive best-practice frameworks tailored to the unique challenges of low-income earners in developing economies. Existing frameworks often lack contextual adaptations and fail to integrate cultural and regional nuances. The findings highlight the need for interdisciplinary approaches that combine technical guidelines with participatory processes to create adaptable and inclusive frameworks.

Meta-Analysis Result

The meta-analysis synthesized findings from 13 peer-reviewed studies published between 2000 and 2024. These studies focused on sustainable housing for low-income earners. Data were categorized into six thematic areas: challenges to sustainable housing, innovative strategies, energy efficiency, indoor environmental quality, sustainable building materials, and best-practice frameworks. Effect sizes, such as Cohen's *d*, Hedges' *g*, standardized mean difference (SMD), and odds ratios (OR), were computed to quantify the impact of various factors on sustainable housing outcomes. A random-effects model was used to account for heterogeneity across studies, given the diverse geographic and socio-economic contexts. Heterogeneity was evaluated using the I^2 statistic to determine the proportion of variance attributable to differences across studies. Funnel plots and Egger's test were computed to assess for publication bias. The result showed no significant bias was detected. Table 2 shows the comprehensive result from the meta-analysis.

Challenges to Sustainable Housing

The analysis showed a substantial effect (d = 0.78, $p < 0.001$) of systemic barriers on the provision of sustainable housing. These include financial constraints, weak policy frameworks, and insecure land tenure, with studies emphasizing the critical role of policy innovation and land reform in addressing these barriers. It is noteworthy that existing studies differ significantly on geographical spreads with respect to challenges affecting sustainable housing provision globally. The geographic location determines prevailing constraints affecting provision of such housing scheme. For example, effects tend to be larger in Sub-Saharan Africa because multiple challenges such as lack of finance, sustainable site selection, tenure insecurity in rural areas adversely affect eco-friendly housing delivery. While in India, Malaysia and Vietnam, barriers are usually administrative, land market related and developer incentives. However, in developed nations, the prevailing challenges are planning constraints, land prices and sustainability performance codes.

Innovative Strategies

Innovative strategies, such as public-private partnerships and modular construction, yielded a moderate positive effect (g = 0.65, $p < 0.01$) on cost-efficiency and scalability. In short, projects using public–private partnerships (PPPs) and industrialized/off-site methods (esp. modular/DFMA) perform meaningfully better than conventional baselines. It is noteworthy that existing studies differ significantly on geographical spreads with respect to innovative strategies for sustainable housing provision globally. However, the long-term impacts of innovative strategies remain underexplored, necessitating further longitudinal research to assess sustainability outcomes. Between-study variability. I^2 = 68% shows substantial heterogeneity—true effects differ across settings, programmes, and measurement choices—so the pooled estimate should be read as an average across diverse conditions. For example, modular construction gives room for early design freeze and factory QA/QC will ensure rework and improve schedule completion for low-rise/mid-rise units.

Energy Efficiency

Energy-efficient technologies demonstrated the highest effect size (SMD = 0.83, $p < 0.001$), indicating their significant potential in reducing operational costs. Nonetheless, high initial costs underscore the need for subsidies and financing mechanisms to enhance accessibility for low-income earners. The existing studies differ significantly on geographical spreads with respect to energy efficiency for sustainable housing provision globally

There is statistically significant improvement relative to business-as-usual. Across outcomes (household energy spend, kWh/m²·yr, peak demand, or thermal-comfort indices), packages that combine passive measures (e.g., cool roofs, insulation/shading, airtightness, efficient fans/LEDs) with renewables (most commonly solar PV) and solar water heating (SWH) produce meaningfully lower operating costs for low-income households.

Table 5: Summarized Result of Meta-analysis

Theme	Effect Size	Confidence Interval (95%)	Significance (p-value)	Heterogeneity (I^2)	Key Findings
Challenges to Sustainable Housing	$d = 0.78$	[0.62, 0.95]	<0.001	72%	Barriers such as financing gaps, weak policies, and insecure land tenure.
Innovative Strategies	$g = 0.65$	[0.50, 0.79]	<0.01	68%	Public-private partnerships and modular construction show potential.
Energy Efficiency	SMD = 0.83	[0.70, 0.95]	<0.001	64%	Renewable energy systems significantly reduce costs but face adoption barriers.
Indoor Environmental Quality	$d = 0.58$	[0.43, 0.73]	<0.01	61%	Ventilation, lighting, and thermal comfort improve well-being but need support.
Sustainable Building Materials	$g = 0.72$	[0.60, 0.85]	<0.001	66%	Eco-friendly materials reduce costs but face durability and acceptance issues.
Best-Practice Frameworks	Weighted Score = 73%	[60%, 85%]	<0.01	59%	Existing frameworks lack cultural and regional integration.

Source: Authors' compilation, 2025

Indoor Environmental Quality

Improved indoor environmental quality had a moderate effect ($d = 0.58$, $p < 0.01$) on resident well-being. It is imperative that existing studies differ significantly on geographical spreads with respect to indoor environmental quality for sustainable housing provision globally. The differences in indoor environmental quality feature in different parts of the world is premised on varying climatic conditions. Also important is the energy tariffs/electricity costs which will affect the justification for using sustainable design. The IEQ is improved with cross-ventilation, trickle through wall vents and screened openings and some instances mechanical/heat recovery. Thermal comfort is also enhanced with the measured heat burdens. Cool roofs, insulated ceilings, external shadings/overhang, higher ceilings lower operative temperatures and perceived heat stress. Passive design strategies show promise but require increased technical capacity and stakeholder awareness for consistent implementation. Across studies, upgrades to ventilation, daylighting/lighting, and thermal comfort consistently improve self-reported well-being, reduce heat stress and indoor air-pollution exposure, and enhance daily functioning.

Sustainable Building Materials

The use of sustainable building materials had a large positive effect ($g = 0.72$, $p < 0.001$) on cost reduction and environmental sustainability. This showed that there is moderately large, reliable benefit versus conventional baselines. Across studies, material switches such as stabilized/compacted earth blocks (SEB/CEB), fly-ash and other blended cements, recycled aggregates, lime–pozzolan mixes, geopolymer binders, timber/bamboo, and hollow/lightweight units are associated with lower life-cycle cost (LCC) and reduced embodied carbon, with no systematic penalty on basic performance when correctly specified and detailed. However, challenges related to standardization, durability, and public perception limit their adoption, highlighting the need for further research and education.

Best-Practice Frameworks

Existing frameworks for sustainable housing scored an average adherence rate of 73% to sustainability principles, with significant gaps in cultural and regional contextualization. Considering p value is less than 0.05, it can thus be said that existing studies differ signifcantly on geographical spread with respect to best practice frameworks for sustainable housing provision. Across the studies that assessed implementation frameworks for sustainable low-income housing, the weighted adequacy score is 73% (95% CI 60–85%, $p < .01$). This indicates that current frameworks are more than passable, but not yet robust across contexts. Heterogeneity $I^2 = 59\%$ (moderate): effectiveness varies materially by country, program type, and how "adequacy" was scored (governance, finance, design, O&M, social safeguards, etc.). This underscores the need for interdisciplinary and participatory approaches to ensure inclusivity and adaptability. This meta-analysis offers robust evidence that innovative strategies, energy-efficient technologies, and sustainable materials are pivotal for advancing housing sustainability for low-income earners. However, systemic barriers and gaps in implementation limit their scalability. While best practice framework signifies the need for it to be applied anywhere in the world, it is evident that framework developed are usually set out to meet the needs of the particular citizen within the study area. Hence, the KPI and related procurement QA for different geographical region will vary. Other variables that will greatly affect the workability of developed framework in other areas include climate, tenure, land markets, finance/mortgage among others.

Discussion of Findings

This study combined a systematic literature review and a meta-analysis to critically evaluate the state of research on sustainable housing for low-income earners. Through this dual approach, the findings were synthesized into six key themes: challenges to sustainable housing, innovative strategies, energy efficiency, indoor environmental quality, sustainable building materials, and the development of a best-practice framework. The analysis also

identified significant gaps in the literature, including insufficient exploration of cost-effective renewable energy technologies for rural areas, inadequate focus on indoor environmental quality in low-income housing, and limited research on lifecycle assessments of sustainable building materials. Additionally, fragmented frameworks with inadequate emphasis on cultural and regional nuances were observed.

The first theme identified in this study is the theme of challenges to sustainable housing. The study highlighted systemic barriers to sustainable housing, with the meta-analysis showing a substantial pooled effect size ($g = 0.78$, $p < 0.001$) for governance-related challenges. Limited access to affordable financing, weak policy frameworks, socio-cultural constraints, and inadequate enforcement of building codes emerged as critical issues. Insecure land tenure, highlighted in studies by Ezennia (2022) and Kheni & Adzraku (2022), was identified as a significant deterrent to long-term investment in housing infrastructure. The findings reinforce arguments by Adedeji et al. (2023) that effective housing policies must address these structural barriers. Innovative policy reforms, cross-sectoral collaboration, and strong political commitment are essential to create enabling environments for sustainable housing solutions.

The study also found the theme of innovative strategies for sustainable housing. The meta-analysis found a moderate positive pooled effect ($g = 0.65$, $p < 0.01$) for innovative strategies in improving housing affordability and scalability. Public-private partnerships (PPPs), modular construction, and community-driven initiatives were identified as promising approaches. Studies by Umana et al. (2024) and Okereke & Okanya (2024) documented successful resource mobilization through PPPs, while Ayo-Odifiri et al. (2022) highlighted the time and cost-saving potential of modular construction. However, the review revealed a lack of mixed methods and longitudinal studies evaluating the long-term affordability and sustainability of these strategies. This underscores the need for localized solutions that integrate cultural, social, and economic factors, as emphasized by Ezennia & Hoskara (2019).

Further, energy efficiency in housing provision emerged as another critical theme. As it showed the highest pooled effect size ($SMD = 0.83$, $p < 0.001$), indicating its critical role in reducing operational costs and improving housing sustainability. Renewable energy technologies, including solar panels and passive cooling designs, were identified as transformative, particularly for low-income households. Studies by Ochedi & Taki (2019) and Bataineh & Al Rabee (2022) emphasized the effectiveness of these technologies, while Sapuan et al. (2022) and Adeyemi et al. (2024) pointed to high upfront costs as a major barrier to widespread adoption. Moreover, the meta-analysis revealed limited exploration of cost-effective solutions tailored for rural communities, highlighting a key area for future research and policy focus.

Another theme identified is the theme of indoor environmental quality and the meta-analysis reported a moderate effect size ($g = 0.58$, $p < 0.01$) for the impact of indoor environmental quality on health and well-being in low-income housing. Common issues included inadequate ventilation, poor natural lighting, and suboptimal thermal comfort, which negatively affect residents' physical and mental health (Saad et al., 2023; Ogunmola & Fadairo, 2022). Passive design strategies, such as optimized window placement and the use of natural materials, were found to improve indoor quality, but their inconsistent implementation remains a challenge due to limited technical expertise and stakeholder awareness. Additionally, the review highlighted insufficient studies addressing the impacts of indoor environmental quality, underscoring a critical gap in the literature.

In addition, the theme of sustainable building materials was identified in the review and sustainable building materials demonstrated a large positive pooled effect ($g = 0.72$, $p < 0.001$) in reducing construction costs and promoting environmental sustainability. Materials such as bamboo, recycled concrete, and compressed earth blocks were identified as cost-effective and eco-friendly options (Kennedy et al., 2021;

Abera, 2024). However, challenges persist, including issues of standardization, durability, and societal acceptance. The review also found limited research on the lifecycle assessments of these materials in developing economies, which is essential for understanding their long-term performance and environmental impact. Public awareness campaigns and government incentives are needed to promote the adoption of sustainable materials.

Furthermore, the theme of framework for sustainable housing was identified. The findings indicated that existing frameworks for sustainable housing remain fragmented and fail to adequately incorporate cultural, regional, and socio-economic nuances. The meta-analysis revealed an adherence rate of 73% to sustainability principles, with significant gaps in participatory and context-specific approaches. Frameworks such as those by Mohammed et al. (2022) and Habibullah et al. (2020) provide valuable technical guidelines but lack integration with local contexts. Turcotte and Geiser (2010) advocate for interdisciplinary frameworks that combine technical expertise with social and cultural considerations. The development of participatory frameworks involving architects, policymakers, and local communities is crucial to ensure sustainability and scalability.

Conclusion

The central objective was to review extant literature on sustainable housing for low-income earners, with the objectives of identifying the current state of research and uncovering gaps and grey areas in literature that requires scholarly attention. A mixed approach was used, which is the use of systematic literature review and a meta-analysis, to conduct a critical appraisal of sustainable housing of low-income earners. This study provides a detailed understanding of the essence of sustainable housing and its consequences on low-income societies by summarising the results of various studies.

The review indicates that some of the persistent barriers to sustainable housing are poor access to affordable financing, poor policy enforcement and the absence of culturally adapted solutions. The meta-analysis demonstrates the existence of a significant pooled effect on variables such as governance and the use of innovative approaches like modular construction and renewable energy technologies. Despite such insights, there are still significant research gaps. Among them are the lack of attention to cost effective renewable energy efficiency solutions to rural populations, lack of exploration of lifecycle assessments of sustainable building materials and inadequate research on indoor environmental quality in low-income housing. In addition, the study also revealed that there is a gap in the incorporation of cultural and regional differences within the sustainable housing literature. The current literature lacks integration and are incapable of responding to the socio-economic conditions of low-income earners, especially in developing economies. The result revealed lack of depth of existing research on sustainable innovative approaches to construction like modular construction etc. The results highlighted the importance of a context-specific, holistic approach to sustainable housing, which integrates technical innovation with social inclusivity and cultural relevance. This would be a stronger basis in designing and implementing sustainable housing projects that target low-income earners.

The meta-analysis shows that sustainability is not a luxury add-on but a high-leverage pathway to improve affordability, resilience, and well-being; provided delivery is designed for the realities of low-income households and local markets. It is imperative to note that existing studies differ significantly on geographical spread with respect to challenges of sustainable housing provision, innovative strategies, energy efficiency, indoor environmental quality, sustainable building materials, best practice frameworks. Hence, no one jacket fix all requirements varies depending on the needs within the region under consideration.

The study recommends that policymakers should endeavour to focus on domestic needs of marginalized demographics such as low-income earners to increase sustainable housing provision and not adopt best-practice

frameworks from other developed and developing countries. The study should encourage context-specific approach taking into consideration climate, tenure, finance availability before embarking on sustainable housing provision. The government should produce financial support in form of rent-to-own, micro-amortization and credit guarantee for marginalized population to help their quest of owning affordable sustainable houses. The study would be beneficial for lenders and funders so as disburse finance based on verified performance (kWh reduction, IEQ thresholds, defect rates) of the developed housing units rather than inputs.

The study contributes to existing knowledge, as it pulls together different research on sustainable housing, while also providing a holistic framework to cover all technical, socio-cultural and economic aspects. Also, it sets the foundation for future scholarly research, as it highlights critical gaps that, once filled, would add value to the literature and encourage the further development of interest in practical sustainable housing. It fills the gap between the technical solutions and socio-cultural realities, emphasising the necessity to adopt a holistic and context-specific approach that combines technical creativity and social inclusivity and cultural responsiveness. Also, this study enriches theoretical discourse by integrating findings into existing frameworks of sustainability and housing development. It highlights the need for interdisciplinary approaches, combining theories of governance, socio-cultural adaptation, and technological innovation. The findings challenge existing frameworks to better incorporate participatory and context-specific elements, thereby advancing theoretical models of sustainable housing. The findings offer actionable insights for housing developers, architects, and project managers, as it draws specific emphasis on the potential benefit of using locally available building materials and energy-efficient designs, which allows practitioners to reduce costs and enhance housing affordability. Additionally, the study identified the need for scalable innovations strategies such as, modular construction that are effective towards addressing housing deficits in rural areas and among low-income earners, while also maintaining high quality and sustainability.

As a social implication, this study addresses a critical social equity issue, as sustainable housing solutions promote community resilience and environmental stewardship, fostering healthier and more equitable societies. The findings emphasize the role of participatory approaches in ensuring that housing solutions are culturally relevant and socially inclusive. This study emphasizes the importance of adopting integrated and adaptive strategies, as stakeholders in the housing sector are encouraged to incorporate lifecycle assessments of materials, prioritize community engagement, and leverage scalable technologies. Cross-sectoral collaborations between developers, policymakers, and local communities are critical for successful implementation.

While this study provides a comprehensive synthesis of sustainable housing literature, it is not without limitations. The reliance on secondary data may have excluded insights from non-indexed publications, and the heterogeneity of reviewed methodologies may limit the generalizability of findings. Hence, future research should address these limitations by conducting mixed method studies that explore context-specific barriers in developing economies. It is suggested that future studies should examine the role of innovative strategies such as modular construction and renewable energy solutions in achieving sustainable low-income housing. There is need for studies to investigate the psychological and health impacts of indoor environmental quality and develop best-practice frameworks that integrate technical, cultural, and socio-economic considerations.

References

Abera, Y. A. (2024). Sustainable building materials: A comprehensive study on eco-friendly alternatives for construction. *Composites and Advanced*

Materials, 33. doi:10.1177/26349833241255957

Adabre, M. A., & Chan, A. P. C. (2019). Critical success factors (CSFs) for sustainable affordable housing. *Building and Environment, 156*, 203–214. https://doi.org/10.1016/j.buildenv.2019.04.025 .

Adedeji, I., Deveci, G., & Salman, H. (2023). The challenges in providing affordable housing in Nigeria and the adequate sustainable approaches for addressing them. *Open Journal of Applied Sciences*, 13(3), 431-448. https://doi.org/10.4236/ojapps.2023.133035

Adedeji, I., Deveci, G., & Salman, H. (2023). The challenges in providing affordable housing in Nigeria and the adequate sustainable approaches for addressing them. *Open Journal of Applied Sciences*, 13(3), 431-448. https://doi.org/10.4236/ojapps.2023.133035

Ajayi, M., Akinsulire, A., & Adegun, A. (2023). Integration of passive design strategies into sustainable housing in Lagos, Nigeria. *Sustainable Cities and Society, 59*, 102240. https://doi.org/10.1016/j.scs.2022.102240

Ajayi, O., Ajayi, O., Akinsiku, O., & Osunsanmi, T. (2016). Strategies for Housing Affordability in Nigeria. *Journal of Construction Project Management and Innovation*, 6(SI), 1620-1632.

Akinsulire, A. A., Idemudia, C., Okwandu, A. C., & Iwuanyanwu, O. (2024). Sustainable development in affordable housing: Policy innovations and challenges. *Magna Scientia Advanced Research and Reviews, 11*(02), 090–104. https://doi.org/10.30574/msarr.2024.11.2.0112

Akinsulire, A. O., Adegun, A. O., & Ajayi, M. (2024). Energy-efficient housing for low-income earners in Nigeria: Opportunities and challenges. *Energy and Buildings, 251*, 111160. https://doi.org/10.1016/j.enbuild.2021.111160

Anusha, M., Surendra, H. J., Dhar, N., Choudhary, M., Khan, I. A., & Pasha, S. F. A. (2024). Enhancing sustainability of polypropylene band and bamboo-reinforced structural elements for rural low-cost housing. *Environment, Development and Sustainability, 26*(2), 3943–3956. https://doi.org/10.1007/s10668-022-02864-9

Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a methodological framework. *International Journal of Social Research Methodology, 8*(1), 19-32. https://doi.org/10.1080/1364557032000119616

Ayo-Odifiri, S. O., Emeana, R. C., Musa, A. W., Ukpabi, I. J., & Ukah, O. T. (2022). Low-income earners housing affordability issues in Nigeria: A systematic review of sustainable approaches. *International Journal of Innovative Research & Development*, 11(2), 37-48. https://doi.org/10.24940/ijird/2022/v11/i2/FEB22016

Bataineh, K., & Al Rabee, A. (2022). Design optimization of energy efficient residential buildings in mediterranean region. *Journal of Sustainable Development of Energy, Water and Environment Systems*, 10(2), 1090385. https://doi.org/10.13044/j.sdewes.d9.0385

Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2009). *Introduction to Meta-Analysis*. Wiley.

Bourbia, S., Kazeoui, H., & Belarbi, R. (2023). A review on recent research on bio-based

building materials and their applications. *Materials Renew Sustain Energy, 12*, 117–139. https://doi.org/10.1007/s40243-023-00234-7

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Chiu, R. L. H. (2006). Social sustainability, sustainable development, and housing development: The experience of Hong Kong. *Housing and the Built Environment*, 21(1), 15–35 .

Dania, S.F., Nor Hasanah, A.S. and Ain Naadia, M. (2021) Sustainable Affordable Housing Strategies for Solving Low-Income Earners Housing Challenges in Nigeria. Studies of Applied Economics, 39, 1-15. https://doi.org/10.25115/eea.v39i4.4571

Department of Human Settlements (Republic of South Africa) (2021) *Annual Report 2020/2021*. Pretoria: DHS. Available at: https://www.gov.za/sites/default/files/gcis_document/202110/department-human-settlements-annual-report-2020-2021.pdf (Accessed: 13 August 2025). South Africa Government

Department of Human Settlements (Republic of South Africa) (2022) *Annual Report 2021/2022*. Pretoria: DHS. Available at: https://www.dhs.gov.za/sites/default/files/reports/DHS_21-22%20AR_web.pdf (Accessed: 13 August 2025). dhs.gov.za

Department of Human Settlements (Republic of South Africa) (2023) *Annual Report 2022/23 (Houses, Security & Comfort)*. Pretoria: DHS. Available at: https://www.dhs.gov.za/sites/default/files/reports/DHSS.pdf (Accessed: 13 August 2025). dhs.gov.za

DLUHC (Department for Levelling Up, Housing & Communities) (2021) *Affordable housing supply: April 2020 to March 2021, England*. London: DLUHC. Available at: https://assets.publishing.service.gov.uk/media/6194ec65d3bf7f05522e2d6a/AHS_2020-21.pdf (Accessed: 13 August 2025). GOV.UK Assets

DLUHC (Department for Levelling Up, Housing & Communities) (2023) *Affordable housing supply in England: 2022 to 2023*. London: DLUHC. Available at: https://www.gov.uk/government/statistics/affordable-housing-supply-in-england-2022-to-2023/affordable-housing-supply-in-england-2022-to-2023 (Accessed: 13 August 2025). GOV.UK

Ebekozien, A., Aigbavboa, C. O., & Samsurijan, M. S. (2023). Appraising alternative building technologies adoption in low-cost housing provision to achieving Sustainable Development Goal 11. *Engineering, Construction and Architectural Management, 31*(13), 41–58. https://doi.org/10.1108/ECAM-06-2023-0538

Ebekozien, A., Aigbavboa, C. O., Samsurijan, M. S., Muhammad, A. K., & Akinradewo, O. (2025). Developing a framework for housing financing: A case study of Nigeria's sustainable low-cost housing via soft system methodology. *Engineering, Construction and Architectural Management, 32*(13), 27–48. https://doi.org/10.1108/ECAM-09-2023-0895

Ebekozien, A., Hafez Ahmed, M. A., Aigbavboa, C., Samsurijan, M. S., Adekunle, S. A., Akinradewo, O., Said, M. Z., & Noor Azazi, N. A. (2024). Equitable post-COVID-19 housing delivery: A practical framework to integrate sustainable development goals in Malaysia's low-cost housing provision. *Journal of Infrastructure Policy and Development, 8*(7).

https://doi.org/10.24294/JIPD.V8I7.4588

Ezennia, I. S. (2022). Insights of housing providers on the critical barriers to sustainable affordable housing uptake in Nigeria. *World Development Sustainability, 1*, 100023. https://doi.org/10.1016/j.wds.2022.100023

Ezennia, I. S., & Hoskara, S. O. (2019). Exploring the severity of factors influencing sustainable affordable housing choice: Evidence from Abuja, Nigeria. *Sustainability, 11*(20), 5792. https://doi.org/10.3390/su11205792

Feist, W. (2018). Passive houses: Sustainable design solutions for the 21st century. *Journal of Sustainable Architecture, 15*(4), 115–130 .

Felgueiras, F., Mourão, Z., Moreira, A., & Gabriel, M. F. (2023). Indoor environmental quality in offices and risk of health and productivity complaints at work: A literature review. *Journal of Hazardous Materials Advances*, 10, 100314. https://doi.org/10.1016/j.hazadv.2023.100314

Gan, X., Zuo, J., Ye, K., & Skitmore, M. (2017). Why sustainable construction? Why not? *Journal of Cleaner Production, 162*, 427–437. https://doi.org/10.1016/j.jclepro.2017.02.040 .

Gao, S. (2025). Sustainable Housing: Innovations and Challenges in Green Architecture. *Journal of Lifestyle and SDGs Review*, *5*(5), e06598. https://doi.org/10.47172/2965-730X.SDGsReview.v5.n05.pe06598

Habibullah, K. M., Umar, M. S., & Hamza, M. (2020). Affordable quality housing strategies for low-income family in Abuja: What lesson from non-profit housing developers? *IRE Journals*, *5*(9), 309.

Haruna, P. B., Zubairu, S., Olagunju, R. E., & Akande, O. K. (2023). Liveability Considerations: Towards Designing Sustainable Public Housing in Niger State, Nigeria. *Journal of Contemporary Urban Affairs*, *7*(2), 262–278. https://doi.org/10.25034/ijcua.2023.v7n2-16

Higgins, J. P. T., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. J., & Welch, V. A. (2020). *Cochrane Handbook for Systematic Reviews of Interventions* (2nd ed.). Wiley-Blackwell.

Khan, K. S., Kunz, R., Kleijnen, J., & Antes, G. (2003). Five steps to conducting a systematic review. *Journal of the Royal Society of Medicine, 96*(3), 118-121. https://doi.org/10.1258/jrsm.96.3.118

Kheni, N. A., & Adzraku, W. D. (2022). An exploratory study of challenges to sustainable housing development in the Kumasi Metropolis of Ghana: Perceptions of built environment consultants. *Journal of Emerging Trends in Economics and Management Sciences, 9*(5), 278–290.

Lok Sabha Secretariat (2025) Unstarred Question No. 1911 (AU1911_VcdFuH): PMAY-U year-wise progress (includes completion and financial details). New Delhi: Lok Sabha. Available at: https://sansad.in/getFile/loksabhaquestions/annex/185/AU1911_VcdFuH.pdf?source=pqals (Accessed: 13 August 2025). Digital Sansad.

Madawaki, M. N. (2013). Factors impeding the access of low-income earners to loans for housing in Nigeria. In *ICCREM 2013: Construction and operation in the context of sustainability* (pp. 1-10). https://doi.org/10.1061/9780784413135.1

Masniari, O., & Koestoer, R. H. (2024). Sustainable building materials for green

construction: A review. *International Research Journal of Advanced Engineering and Science*, *9*(2), 68–72.

Mehmood R, Yigitcanlar T, Corchado JM. Smart Technologies for Sustainable Urban and Regional Development. *Sustainability*. 2024; 16(3):1171. https://doi.org/10.3390/su16031171

Mewomo, M. C., Toyin, J. O., Iyiola, C. O., & Aluko, O. R. (2023). Synthesis of critical factors influencing indoor environmental quality and their impacts on building occupants' health and productivity. *Journal of Engineering, Design and Technology, 21*(2), 619-634. https://doi.org/10.1108/JEDT-10-2021-0595

Moghayedi, A., Phiri, C., & Ellmann, A.-M. (2023). Improving sustainability of affordable housing using innovative technologies: Case study of SIAH-Livable. *Scientific African, 21*, e01819. https://doi.org/10.1016/j.sciaf.2023.e01819

Mohammed, B. U., Alfetais, A. M., & Habibullah, K. M. (2022). Strategies for sustainable low-income affordable housing needs in Abuja Municipal Area Council (AMAC): Policy, issues and challenges. *Quest Journals Journal of Architecture and Civil Engineering, 7*(9), 21–33.

Nigerian Economic Summit Group. (n.d.). *Nigerian Economic Summit Group*. Retrieved December 7, 2024, from https://www.nesgroup.org/

Nubi, G., & Afe, Y. (2014). Redefining Affordable Housing through Sustainable Practices. http://www.salford.ac.uk/__data/assets/pdf_file/0003/142419/058-Nubi.pdf.

Obianyo, I. I., Ihekweme, G. O., Mahamat, A. A., Onyelowe, K. C., Onwualu, A. P., & Soboyejo, A. B. O. (2021). Overcoming the obstacles to sustainable housing and urban development in Nigeria: The role of research and innovation. *Cleaner Engineering and Technology, 4,* 100226. https://doi.org/10.1016/j.clet.2021.100226

Ochedi, E. T., & Taki, A. (2022). A framework approach to the design of energy-efficient residential buildings in Nigeria. *Energy and Built Environment, 3(3)*, 384-397. https://doi.org/10.1016/j.enbenv.2021.07.001

Ogundipe, O., Omisore, A., & Fashanu, O. (2024). The role of public-private partnerships in affordable housing for low-income earners in Nigeria. *Cambridge Research Journals*, *12*(2), 123-140. https://cambridgeresearchpub.com/ijeres/article/view/338/337

Ogunmola, A. F., & Fadairo, G. (2022). Improving indoor air quality in condominiums through green architecture. *British Journal of Environmental Sciences*, 10(5), 1-14. Publication of the European Centre for Research Training and Development - UK

Okereke, G. K., & Okanya, A. (2024). Achieving sustainable housing for low and middle-income earners. In *Prefabricated construction for sustainability and mass customization*. https://doi.org/10.5772/intechopen.111870

Olotuah, A. O., & Adesiji, A. (2020). Integrating traditional and modern practices for sustainable rural housing in Nigeria. *International Journal of Sustainable Built Environment, 9*(2), 198–207 .

Olubi, A. R., & Aseyan, B. S. (2021). Sustainable housing delivery for the urban poor in Nigeria. *International Journal of Civil Engineering,*

Construction and Estate Management, 10(1), 21-34.

Olubi, A. R., & Aseyan, B. S. (2021). Sustainable housing delivery for the urban poor in Nigeria. *International Journal of Civil Engineering, Construction and Estate Management*, 10(1), 21-34.

Oyetunji, A. K., Oluleye, B. I., Olukolajo, M. A., & Chan, D. W. M. (2022). Is green good: Unveiling the latent benefits of sustainable housing delivery. *Cities, 129*, 103809. https://doi.org/10.1016/j.cities.2022.103809

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ, 372*, n71. https://doi.org/10.1136/bmj.n71

Piroozfar, P. A. E., & Pullen, S. F. (2012). Inclusive housing design: Energy-efficient and sustainable homes. *Building and Environment, 47*(1), 77–87.

Press Information Bureau (Government of India) (2023) *Details of the number of houses constructed under the Pradhan Mantri Awaas Yojana-Gramin (PMAY-G) during each of the last four years and present year*. Posted 1 August 2023. New Delhi/Mumbai: PIB. Available at: https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=1944808 (Accessed: 13 August 2025). Press Information Bureau

Richards, R. (2025) *Priorities for Affordable Housing in Nigeria*. Brighton: Institute of Development Studies (IDS). Available at: https://opendocs.ids.ac.uk/articles/report/Priorities_for_Affordable_Housing_in_Nigeria/29476442 (Accessed: 13 August 2025).

Saad, S., Assem, A., & Fathy, F. (2023). Enhancing indoor environmental quality in the post-pandemic era: Challenges, strategies, and solutions. *International Journal of Engineering Research & Technology*, 12(09), 1-9.

Sapuan, N. M., Faizah, H. N., Kumaran, V. V., & Ridzuan, A. R. (2022). Green building best practices in achieving energy and environmental sustainability. *Environmental Management and Sustainable Development, 11*(4), 74-92. https://doi.org/10.5296/emsd.v11i4.21052

Sertyesilisik, B., Tunstall, D., & Korkmaz, S. (2021). Modular construction for affordable and sustainable housing. *Sustainable Development Journal, 33*(2), 189–202 .

Singh, J. (2013). Critical appraisal skills programme. *Journal of Pharmacology and Pharmacotherapeutics, 4*(1), 76-77. https://doi.org/10.4103/0976-500X.107697

Taylor, J., & Howden-Chapman, P. (2021). The significance of urban systems on sustainability and public health. *Urban Systems for Sustainability and Health, 2*(1), 874–887. https://doi.org/10.5334/bc.181

Turcotte, D. A. & Geiser, K. (2010). A Framework to Guide Sustainable Housing Development. *Housing and Society*, *37*(2), 87–117. https://doi.org/10.1080/08882746.2010.11430582

Tynkkynen, N., Henriksson, L., Egner, B., Lahtinen, V., Landrock, J., & Grönberg, C. (2025). Housing, climate, and their challenges. In *How to achieve sustainable housing?*. SpringerBriefs in Political Science. Springer, Cham. https://doi.org/10.1007/978-3-031-86386-8_2

Umana, A. U., Garba, B. M. P., Ologun, A., Olu, J. S., & Umar, M. O. (2024). Innovative design solutions for social housing: Addressing the needs of youth

in urban Nigeria. *World Journal of Advanced Research and Reviews*, 23(03), 383–396. https://doi.org/10.30574/wjarr.2024.23.3.2700.

UN-Habitat. (2016). *Sustainable housing for sustainable cities: A policy framework for developing countries*. United Nations Human Settlements Programme .

Wesonga, R., Kasedde, H., Kibwami, N., & Manga, M. (2023). A comparative analysis of thermal performance, annual energy use, and life cycle costs of low-cost houses made with mud bricks and earthbag wall systems in Sub-Saharan Africa. *Energy and Built Environment, 4*(1), 13–24. https://doi.org/10.1016/j.enbenv.2021.06.001