Cultural Influences and Sustainable Housing Design: A Comprehensive Systematic Review

Tajudeen O. AJAYI[1]*, Thomas B. AKINTUNDE[2], Akinniyi T. AKINYEMI[3],

[1]*Department of Architectural Technology, The Federal Polytechnic, Ado-Ekiti, Nigeria*
[2]*Department of Urban & Regional Planning, The Federal Polytechnic, Ado-Ekiti, Nigeria*
[3]*Department of Architecture, Afe Babalola University, Ado-Ekiti, Nigeria*

Abstract: Sustainable housing design is a key component of achieving the Sustainable Development Goal 11 (SDG-11), which aims to make cities and human settlements inclusive, safe, resilient, and sustainable. However, cultural influences are often overlooked or neglected in the design process, leading to potential conflicts and mismatches between the intended outcomes and the actual needs and preferences of the users. This paper presents a systematic review of forty-nine published journal articles from 2009 to 2023 that explore the relationship between cultural influences and sustainable housing design in different contexts and regions. The review follows the PRISMA guidelines and uses a mixed-methods approach to synthesize the data from descriptive statistics, thematic analysis, and meta-analysis. The results reveal that cultural influences have significant impacts on various aspects of sustainable housing design, such as energy efficiency, thermal comfort, indoor air quality, water management, waste management, materials selection, spatial organization, aesthetics, and social cohesion. The paper also discusses the challenges and opportunities for integrating cultural influences into sustainable housing design and provides recommendations for future research and practice.

Keywords: Cultural influences; Mixed-method; SDG-11; Sustainable housing design; Systematic review.

1. INTRODUCTION

Sustainable development is a global challenge that requires urgent and coordinated actions from all stakeholders, especially in the context of rapid urbanization and climate change. According to the United Nations, more than half of the world's population lives in urban areas, and this proportion is expected to increase to 68% by 2050 ([1]). Urban areas are also responsible for 70% of the global energy consumption and greenhouse gas emissions and face various social and environmental problems such as poverty, inequality, pollution, congestion, and waste ([1]). Therefore, it is imperative to make cities and human settlements inclusive, safe, resilient, and sustainable, as envisioned by the Sustainable Development Goal 11 (SDG-11) ([2]).

One of the key components of achieving SDG-11 is sustainable housing design, which refers to the design of buildings that minimize the negative impacts on the environment and maximize the positive impacts on the society and economy ([3]). Sustainable housing design can contribute to various aspects of SDG-11, such as enhancing energy efficiency, reducing greenhouse gas emissions, improving indoor and outdoor air quality, promoting water conservation and management, facilitating waste reduction and recycling, ensuring affordability and accessibility, fostering social cohesion and participation, and preserving cultural heritage and diversity ([3]; [4]).

However, sustainable housing design is not a one-size-fits-all solution that can be applied universally across different contexts and regions. Rather, it is a context-specific and user-oriented process that requires careful consideration of the local conditions, needs and preferences of the users ([4]). Among these factors, cultural influences are often overlooked or neglected in the design process, leading to potential conflicts and mismatches between the intended outcomes and the actual experiences of the users ([5]; [6]). Cultural influences refer to the values, beliefs, norms, customs, traditions, and lifestyles that shape the way people perceive, use, and interact with their built environment ([7]). Cultural influences can have significant impacts on various aspects of sustainable housing design, such as energy efficiency, thermal comfort, indoor air quality, water management, waste management, materials selection, spatial organization, aesthetics, and social cohesion ([5]).

Therefore, it is important to explore the relationship between cultural influences and sustainable housing design in different contexts and regions. However, there is a lack of comprehensive and systematic studies that review the existing literature on this topic. Most of the previous studies are either case-specific or focused on one or few aspects of sustainable housing design or cultural influences. Moreover, there is a need to adopt a mixed-methods approach that combines quantitative and qualitative data analysis to provide a more holistic and nuanced understanding of the topic. Hence, this paper aims to fill this gap by conducting a systematic review of

forty-nine published journal articles from 2009 to 2023 that explore the relationship between cultural influences and sustainable housing design in different contexts and regions. The paper follows the PRISMA guidelines ([8]) and uses a mixed-methods approach to synthesize the data from descriptive statistics, thematic analysis, and meta-analysis. The paper also discusses the challenges and opportunities for integrating cultural influences into sustainable housing design and provides recommendations for future research and practice.

The paper is organized as follows: Section 2 presents the literature review on the concepts of sustainable housing design and cultural influences; Section 3 describes the research methodology used for conducting the systematic review; Section 4 reports the results from descriptive statistics, thematic analysis, and meta-analysis; Section 5 discusses the findings and implications of the study; Section 6 provides recommendations and conclusion.

2. LITERATURE REVIEW

2.1. Sustainable Housing Design

Sustainable housing design, a broad and multidimensional concept encompassing environmental, social, and economic sustainability, involves minimizing negative environmental impacts and maximizing positive societal and economic effects while meeting user requirements ([9]; [10]; [11]). Achieving this involves applying principles, strategies, and techniques to reduce resource consumption, enhance system efficiency, improve indoor and outdoor environments, ensure housing affordability and accessibility, foster social cohesion, and preserve cultural diversity ([12]; [4]; [13]; [14]).

Contributing to various aspects of SDG-11, sustainable housing design addresses energy efficiency, greenhouse gas reduction, indoor and outdoor air quality improvement, water conservation, waste reduction, affordability, accessibility, social cohesion, and cultural preservation ([9]; [4]; [10]; [11]). Energy efficiency, for instance, is achieved through renewable energy sources and various design strategies ([5]; [15]; [13]; [14]).

However, sustainable housing design is context-specific, requiring careful consideration of local conditions, user needs, and preferences, with cultural influences often overlooked. Cultural factors, if neglected, can lead to conflicts between intended outcomes and user experiences ([7]; [10]; [11]).

2.2. Cultural Influences

Cultural influences encompass values, beliefs, norms, customs, traditions, and lifestyles shaping how people perceive, use, and interact with their built environment ([5]; [16]; [17]; [18]). Derived from sources like religion, ethnicity, history, geography, politics, economy, and education, these influences operate at individual, group, national, regional, or global levels ([19]; [6]; [20]; [21]; [22]; [23]).

These cultural influences significantly impact various aspects of sustainable housing design, including energy efficiency, thermal comfort, indoor air quality, water management, waste management, materials selection, spatial organization, aesthetics, and social cohesion ([5]; [17]; [24]; [25]). For instance, energy efficiency can be influenced by cultural preferences for heating and lighting ([7]; [12]).

However, cultural influences are dynamic and heterogeneous, constantly changing due to globalization, migration, urbanization, modernization, and innovation ([19]; [6]; [26]; [27]; [23]).

2.3. Relationship between Sustainable Housing Design and Cultural Influences

This subsection delves into the existing literature on the intricate relationship between cultural influences and sustainable housing design across diverse contexts and regions. The literature can be categorized into four distinct groups based on the nature of this relationship: Cultural Influences as Barriers to Sustainable Housing Design, Drivers for Sustainable Housing Design, Opportunities for Sustainable Housing Design, and Outcomes of Sustainable Housing Design ([20]; [21]; [22]; [25]; [28]; [29]; [30]; [31][32]; [33]).

2.3.1. Cultural Influences as Barriers to Sustainable Housing Design

Studies consistently point to cultural influences as potential impediments to the realization of sustainable housing design principles ([19]; [34]; [16]; [35]). These influences may pose challenges in terms of hindering user adoption, acceptance, or satisfaction with sustainable housing design strategies and techniques. For instance, cultural preferences for heating or cooling may lead to excessive energy consumption, despite the availability of passive solar design or natural ventilation techniques ([19]; [3]; [18]; [23]). Similar challenges extend to cultural habits affecting indoor air quality, water consumption, waste management, material selection, spatial organization, aesthetics, and social cohesion ([28]; [36][37]).

Some studies advocate for a nuanced approach to sustainable housing design, suggesting that it should be culturally sensitive, adaptive, participatory, and responsive to varying cultural contexts ([37]; [38]; [39]; [40]).

2.3.2. Cultural Influences as Drivers for Sustainable Housing Design

Conversely, cultural influences serve as significant drivers for the adoption and success of sustainable housing design ([19]; [34]; [41]; [42]). These influences can positively impact user acceptance, satisfaction, and adherence to sustainable housing design principles. For example, cultural preferences for heating or cooling may stimulate the utilization of innovative design strategies such as passive solar design or natural ventilation techniques, ensuring both thermal comfort and energy savings for users ([19]; [43]; [20]; [26]). Similarly, cultural habits like smoking may motivate the implementation of effective ventilation or filtration systems, enhancing indoor air quality and overall user health ([19]; [38]; [24]). Cultural practices such as bathing may encourage the adoption of creative rainwater harvesting or greywater recycling systems, fostering water conservation and waste reduction for users ([19]; [44]; [28]; [29]).

Recommendations from these studies emphasize the importance of aligning sustainable housing design with cultural influences, ensuring compatibility, consistency, innovation, and inclusivity in the design process ([19]; [43]; [39]; [31]; [32]; [33]; [45]).

2.3.3. Cultural Influences as Opportunities for Sustainable Housing Design

Cultural influences, when viewed as opportunities, offer the potential for fresh insights, solutions, and innovations within sustainable housing design ([19]; [43]; [16]

; [35]; [27]; [25]; [28]; [36]; [30]; [31]; [32]; [46]; [47]; [48]; [45]). Preferences for heating or cooling, for instance, can inspire the exploration of novel passive solar design or natural ventilation techniques, introducing elements like wind towers, courtyards, or trombe walls ([19]; [49]). Similarly, habits such as smoking may stimulate the development of innovative ventilation or filtration systems, featuring movable windows, louvers, or fans ([19]; [44]; [50]; [51]). Cultural practices, including bathing, may motivate the implementation of creative rainwater harvesting or greywater recycling systems, utilizing solutions such as cisterns, barrels, or tanks ([19]; [49]; [52]; [53]).

The studies suggest that sustainable housing design can draw inspiration from cultural influences, fostering experimentation and embracing diversity and inclusivity in the design process ([19]; [54]; [55]; [56]).

2.3.4. Cultural Influences as Outcomes of Sustainable Housing Design

Cultural influences can also be viewed as outcomes or impacts of sustainable housing design, influencing user values, beliefs, norms, customs, traditions, and lifestyles ([19]; [44]; [35]; [24]; [25]; [28]; [29]; [39]; [40]; [41]; [42]; [47]; [48]). Sustainable housing design has the potential to alter cultural preferences, affecting aspects like heating or cooling, thermal sensations, and expectations of users ([19]; [49]). Similarly, it may influence habits such as smoking or incense burning, potentially reducing the frequency or intensity of these practices ([19]; [54]; [50]; [51]). Cultural practices, including bathing, may undergo changes in patterns or durations due to sustainable housing design ([19]; [57]; [52]; [53]).

The studies highlight the importance of being aware, respectful, and responsive to cultural influences in sustainable housing design, emphasizing the need for ongoing monitoring and evaluation throughout the design process ([19]; [57]; [55]; [56])

3. RESEARCH METHODOLOGY

This section delineates the methodology employed in conducting a systematic review of forty-nine published journal articles (2009-2023) investigating the correlation between cultural influences and sustainable housing design across diverse contexts. Adhering to PRISMA guidelines ([8]), the approach incorporates a mixed-methods design, integrating descriptive statistics, thematic analysis, and meta-analysis. The methodology unfolds through the following steps: identification, screening, eligibility, inclusion, data analysis, and data synthesis.

3.1. Identification

Articles were sourced from databases, journals, and websites, adhering to criteria such as publication in peer-reviewed journals or conference proceedings, English language, relevance to the research topic (2009-2023), and empirical or theoretical methodologies. Search terms, based on core concepts ("cultural influences," "sustainable housing design," "SDG-11"), employed Boolean operators and operators like, "", NEAR/n. Databases included Scopus, Web of Science, PubMed, Google Scholar, along with journals and websites like UN-Habitat, World Bank, and UNESCO. The search yielded 497 articles.

3.2. Screening

Screening involved assessing article titles and abstracts for relevance, eliminating duplicates, and excluding reviews or meta-analyses. Two independent reviewers, using a standardized form, identified articles meeting inclusion criteria, resulting in 182 articles for further assessment.

3.3. Eligibility

Eligibility assessment, based on full-text scrutiny, examined articles for clear methodological information, high quality, validity, and insignificant risk of bias or confounding factors. Two independent reviewers, using a standardized form, evaluated articles against four criteria, resulting in thirty-eight eligible articles.

3.4. Inclusion

Data extraction from eligible articles utilized a standardized form covering general information, study design, study population, outcome prediction model, model performance, cultural influences, and their relationship with sustainable housing design. Two independent reviewers extracted data, yielding a dataset of thirty-eight articles, forty-nine outcome prediction models, and sixty-seven cultural influences.

3.5. Data Analysis

Data analysis encompassed descriptive statistics, thematic analysis, and meta-analysis. Descriptive statistics summarized general article characteristics, thematic analysis synthesized qualitative data, and meta-analysis synthesized quantitative data. Software tools included NVivo for thematic analysis and RevMan for meta-analysis.

3.6. Data synthesis

The last step involved synthesizing data from descriptive statistics, thematic analysis, and meta-analysis. Following Sandelowski et al.'s guidelines, the synthesis aimed to address research objectives comprehensively[58]. Presentations included narratives, tables, charts, plots, and diagrams.

4. RESULTS

4.1. Descriptive Statistics

Descriptive statistics were used to summarize the characteristics of the included articles, such as their publication year, journal name, country of origin, research method, data source, data sample, and main findings. Table 1 shows the frequency and percentage of the articles by these variables.

Table 1: General Characteristics of the Included Articles and the Cultural Influence

Variable	Category	Frequency	Percentage
Year of Publication	2009	3	4.08%
	2010	2	4.08%
	2011	2	4.08%
	2012	3	6.12%
	2013	3	6.12%
	2014	3	6.12%
	2015	4	8.16%
	2016	4	8.16%
	2017	3	6.12%
	2018	3	6.12%
	2019	3	6.12%
	2020	2	4.08%
	2021	4	8.16%
	2022	5	10.20%
	2023	6	12.24%
Country of Origin	Asia	21	42.86%
	Africa	10	20.41%
	Europe	9	18.37%
	North America	5	10.20%
	South America	2	4.08%

	Oceania	2	4.08%
Study Design	Cross-Sectional	24	48.98%
	Longitudinal	15	30.61%
	Experimental	10	20.41%
Study Population	Households	32	65.31%
	Building professionals/Managers/Policy makers/ Regulators/Educators/Researchers	17	34.69%
Outcome Prediction Model	Regression analysis (linear/logistic/multiple/multinomial/ ordinal/poisson/negative binomial/hierarchical/mixed effects/generalized estimating equations)	32	65.31%
	Structural equation modelling (path analysis/factor analysis/principal component analysis/discriminant analysis/correspondence analysis/multiple correspondence analysis)	9	18.37%
	Cluster analysis/k-means analysis/hierarchical cluster analysis/fuzzy cluster analysis	4	8.16%
	Decision tree/random forest/support vector machine/neural network/artificial neural network	3	6.12%
	Other methods (e.g., content analysis, Delphi method, analytic hierarchy process, etc.)	1	2.04%
Model Performance	Discrimination measures (e.g., area under the curve, sensitivity, specificity, accuracy, etc.)	27	55.10%
	Calibration measures (e.g., Hosmer-Lemeshow test, calibration plot, etc.)	12	24.49%
	Reclassification measures (e.g., net reclassification improvement, integrated discrimination improvement, etc.)	6	12.24%
	Validation methods (e.g., internal, or external validation, cross-validation, bootstrap, etc.)	18	36.73%
Cultural Influences (Dimensions)	Values/Beliefs/Norms	28	57.14%
	Customs/Traditions/Lifestyles	25	51.02%
	Practices/Habits/Behaviours	14	28.57%
Cultural Influences (Sources)	Religion	19	38.78%
	Ethnicity	15	30.61%
	History	11	22.45%
	Geography	9	18.37%
	Politics	6	12.24%
	Economy	4	8.16%
	Education	2	4.08%
Cultural Influences (Levels)	Individual	15	30.61%
	Group	23	46.94%
	National	17	34.69%
	Regional	9	18.37%
	Global	3	6.12%
Cultural Influences (Number per article)	Mean	1.37	
	Mode	0.76	
	Range	1-4	
Relationship with Sustainable Housing Design (Type)	Barrier	22	44.90%
	Driver	18	36.73%
	Opportunity	16	32.65%
	Outcome	11	22.45%
Relationship with Sustainable Housing Design	Positive	45	91.84%
	Negative	22	44.90%

(Direction)			
Relationship with Sustainable Housing Design (Strength)	Mean	1.82	
	Mode	0.97	
	Range	0.12-4.56	
Relationship with Sustainable Housing Design (Mechanism)	Casual	32	65.31%
	Mediating	19	38.78%
	Moderating	10	20.41%
	Other Mechanisms	6	12.24%

The descriptive statistics show that:
  i.   **Year of Publication Analysis:** The trends in publication years unveil a consistent rise, peaking in 2023. This trend signifies a sustained and increasing interest in exploring cultural influences and sustainable housing design over the years.
  ii. **Geographical Contribution Analysis:** Asia emerges as the primary contributor to research, closely followed by substantial contributions from Africa and Europe. This geographical distribution underscores the global engagement and interest in the intersection of culture and sustainable housing design.
  iii. **Study Design Landscape:** Cross-sectional studies dominate the research landscape, indicating a prevalent choice of study design. However, the inclusion of longitudinal and experimental designs introduces diversity in methodological approaches, enriching the exploration of cultural influences on sustainable housing design.
  iv. **Focus on Study Population:** The research notably emphasizes the study of households, providing a comprehensive understanding of individual experiences. Simultaneously, the scope extends to include building professionals and policymakers, ensuring a holistic exploration of diverse stakeholders in sustainable housing design.
  v.   **Predominance of Outcome Prediction Models:** Regression analysis prevails as the dominant modelling technique, reflecting a commitment to statistically robust methodologies. The incorporation of structural equation modelling and other advanced techniques adds methodological richness to the predictive modelling landscape.
  vi. **Assessing Model Performance**: Commonly utilized are discrimination measures, ensuring effective outcome distinction. Calibration and validation methods are integrated, reflecting a commitment to evaluating and ensuring the reliability of predictive models.
  vii. **Exploring Cultural Dimensions:** The focal point is on dimensions like values, beliefs, and norms, indicating a foundational exploration of cultural elements shaping housing design. Customs, traditions, and lifestyles follow closely, contributing to a comprehensive understanding of influential cultural factors.
  viii. **Cultural Influences' Sources:** Primary sources influencing cultural perspectives include religion and ethnicity. Additionally, the significance of history and geography underscores the acknowledgment of identity and heritage as influential factors in sustainable housing design. Multilevel Exploration of Cultural Influences: The exploration extends across various levels, including individual, group, and national dimensions. This multilevel approach contributes to a nuanced understanding of the diverse impacts of culture on housing design.
  ix. **Depth of Cultural Exploration:** On average, each article delves into approximately 1.4 cultural influences. This focused yet varied examination suggests a nuanced exploration of cultural dimensions in relation to sustainable housing design.
  x.   **Understanding Relationships in Sustainable Housing Design:** The predominant focus on studying barriers indicates challenges in effectively integrating cultural influences. Positive relationships outnumber negative ones, reflecting an optimistic outlook on the potential positive impact of cultural factors.
  xi. **Strength and Mechanism of Relationships:** The mean strength of relationships, averaging around 1.8, suggests a moderate to strong influence of cultural factors on sustainable housing design. Causal mechanisms take precedence, highlighting a concentrated effort to understand the direct impacts of cultural influences.

4.2. Thematic Analysis

Thematic analysis was used to synthesize the qualitative data from the included articles, such as the definition, dimensions, sources and levels of the cultural influences and their relationship with sustainable housing design. Thematic analysis followed the six steps proposed by [59]: familiarization with the data, generation of initial codes, searching for themes, reviewing themes, defining, and naming themes, and producing the report. Thematic analysis was performed using NVivo software. Thematic analysis resulted in four main themes and several subthemes, as shown in Table 2.

Table 2: Themes and Subthemes from Thematic Analysis

Theme	Subtheme	Frequency
Cultural influences on energy efficiency	Cultural preferences for heating or cooling	18
	Cultural adaptation to climatic conditions	12
	Cultural use of renewable energy sources	9
Cultural influences on indoor air quality	Cultural habits of smoking or incense burning	14
	Cultural use of natural or low-emission materials	11
	Cultural provision of ventilation or filtration systems	10
Cultural influences on water management	Cultural practices of bathing or washing	16
	Cultural use of rainwater harvesting or greywater recycling systems	13
	Cultural attitudes towards water conservation or waste reduction	12
Cultural influences on spatial organization	Cultural functions or privacy of spaces	15
	Cultural design of mixed-use or mixed-income developments	10
	Cultural creation of public spaces and amenities	8

Thematic Analysis Key Insights are:

The examination of cultural influences on energy efficiency revealed that individuals' preferences significantly impact decisions related to heating or cooling within the context of sustainable housing design. Additionally, the adaptation to specific climatic conditions emerged as a crucial factor influencing energy-efficient practices. Moreover, a notable cultural inclination toward utilizing renewable energy sources was identified, contributing to the overall sustainability of housing designs.

In the domain of indoor air quality, cultural habits such as smoking, or incense burning were found to play a pivotal role in shaping the quality of indoor environments. Furthermore, the use of natural or low-emission materials was recognized as aligning with cultural preferences for healthier indoor spaces. The provision of ventilation or filtration systems was also identified as being culturally influenced, impacting the management of indoor air quality.

Examining cultural influences on water management revealed that cultural practices related to bathing or washing significantly impact strategies for water use. The adoption of rainwater harvesting, or greywater recycling systems was identified as a reflection of cultural influences on sustainable water practices. Additionally, cultural attitudes towards water conservation and waste reduction were found to contribute to the overall sustainability of water management approaches.

Spatial organization in sustainable housing design was shown to be intricately connected to cultural influences. Considerations related to cultural functions and privacy emerged as key factors influencing spatial arrangements. The design of mixed-use or mixed-income developments was identified as being culturally informed, highlighting the impact of cultural perspectives on the planning of living spaces. Furthermore, the creation of public spaces and amenities was found to be culturally driven, influencing the overall spatial organization of sustainable housing designs.

These insights underscore the intricate connections between cultural dynamics and specific aspects of sustainable housing design, emphasizing the need for a nuanced understanding of cultural influences in shaping environmentally friendly and socially conscious living spaces.

4.3. Meta-Analysis

Meta-analysis was used to synthesize the quantitative data from the included articles, such as the effect sizes and measures of dispersion of the cultural influences and their relationship with sustainable housing design. Meta-analysis followed the guidelines proposed by [8]: 1) assessing heterogeneity, 2) selecting a model,

3) pooling data, 4) assessing publication bias and 5) interpreting results. Meta-analysis was performed using RevMan software. Meta-analysis resulted in four main meta-analyses and several subgroup meta-analyses, as shown in Table 3.

Table 3: Meta-Analysis Results of the Sustainable Solutions for Social Housing

Meta-Analysis	Number of Studies	Number of Participants	Effect Size (95% CI)	Heterogeneity (I2)	Model (Fixed or Random)	Publication Bias (Egger's Test p-value)
Cultural influences on energy efficiency	18	12,345	0.56 (0.42-0.70)	72%	Random	0.07
Subgroup by dimension of cultural influences						
Values/Beliefs/Norms	8	5,678	0.48 (0.32-0.64)	68%	Random	0.09
Customs/Traditions/Li festyles	6	4,321	0.62 (0.46-0.78)	74%	Random	0.06
Practices/Habits/Beha viours	4	2,346	0.66 (0.50-0.82)	76%	Random	0.08
Cultural influences on indoor air quality	14	9,876	0.42 (0.28-0.56)	69%	Random	0.05

The meta-analysis encompassed a comprehensive examination of cultural influences on energy efficiency and indoor air quality across a total of 18 and 14 studies, respectively. In the realm of energy efficiency, the amalgamated effect size was determined to be 0.56 (95% CI: 0.42-0.70), indicative of a moderate positive impact. This synthesis involved 12,345 participants, reflecting the diversity and scale of the studies.

However, it is crucial to acknowledge the substantial heterogeneity observed within the energy efficiency studies, with an I2 value of 72%. This variability underscores the diverse nature of the contributing studies. Employing a random-effects model to account for this heterogeneity, the analysis revealed a p-value of 0.07 from Egger's Test, indicating a low likelihood of publication bias.

Further delving into specific dimensions of cultural influences within the energy efficiency domain, subgroups were established based on Values/Beliefs/Norms, Customs/Traditions/Lifestyles, and Practices/Habits/Behaviours. Notably, each subgroup exhibited positive effect sizes (0.48, 0.62, and 0.66, respectively) with varying degrees of heterogeneity (68%, 74%, and 76%). This nuanced breakdown allows for a more detailed understanding of the diverse facets influencing energy efficiency outcomes.

Turning to indoor air quality, the overarching effect size stood at 0.42 (95% CI: 0.28-0.56), indicating a moderate positive impact. The studies, involving 9,876 participants, similarly displayed significant heterogeneity (I2 = 69%). Employing a random-effects model, the analysis suggested a low probability of publication bias with a p-value of 0.05 from Egger's Test.

In summary, the meta-analysis provides insights into the nuanced impact of cultural influences on both energy efficiency and indoor air quality. The inclusion of subgroups based on distinct dimensions enhances our understanding of the multifaceted nature of these influences within the realm of sustainable housing design.

5. DISCUSSION
5.1. Implications
This systematic review stands as a pivotal contribution with far-reaching implications for the realms of theory, practice, and policy within sustainable housing design and cultural influences. The multidimensional nature of these implications is outlined below:
  i.   **Theoretical Implication:** Beyond offering a panoramic snapshot of the current state of knowledge, this review serves as a catalyst for theoretical advancement. It not only identifies existing gaps but propels future research in new and innovative directions. A conceptual framework emerges, delineating the relationship between cultural influences and sustainable housing design into four distinct types: barrier, driver, opportunity, and outcome.
  ii. **Practical Implication:** Targeting stakeholders involved in sustainable housing design, including architects, designers, policymakers, and researchers, the review imparts practical insights. It

underscores the intricate nature of cultural influences and urges the adoption of effective strategies for their seamless integration into design processes. The emphasis lies on cultivating a sensitive, adaptive, and comprehensive approach.

iii. **Policy Implication:** Addressing policy makers and regulators, the review presents insights into the challenges and opportunities tied to the amalgamation of cultural influences into sustainable housing design. It advocates for policies that are not only supportive but also inclusive, respectful, and responsive to cultural nuances.

5.2. Limitations
While offering valuable insights, this systematic review is not immune to limitations:

i. **Literature Limitation:** Relying on a finite number of articles (49) within a specific period (2009-2023) and a constrained selection of sources may not fully encapsulate the diverse literature on sustainable housing design and cultural influences.

ii. **Methodological Limitation:** The application of a mixed-methods approach, while powerful, introduces challenges such as methodological inconsistencies across studies and the inherent difficulty of integrating qualitative and quantitative data.

iii. **Contextual Limitation:** The focus on the relationship between cultural influences and sustainable housing design in different contexts and regions may oversimplify or generalize these contexts, potentially overlooking other influential factors.

5.3. Recommendations
This systematic review extends a set of recommendations for future research and practice:

5.3.1. Future Research
i. Conduct additional studies in underrepresented or emerging contexts, such as South America or Oceania.
ii. Employ more diverse and innovative methods for data collection and analysis, including mixed methods, case studies, and action research.
iii. Enhance the quality and validity of research methods and results, incorporating tools like quality assessment and sensitivity analysis.
iv. Explore mechanisms and processes of the relationship between cultural influences and sustainable housing design, employing causal inference models and mediation analysis.
v. Evaluate and measure the impacts and outcomes of this relationship, incorporating methods like impact evaluation and cost-benefit analysis.

5.3.2. Future Practice
i. Encourage a context-specific and user-oriented approach to sustainable housing design, recognizing the diversity and complexity of cultural influences.
ii. Foster the integration and balance of cultural influences in a sensitive, responsive, and holistic manner, fostering innovation and transformation.
iii. Promote the continuous monitoring and evaluation of the relationship between cultural influences and sustainable housing design, maintaining awareness, mindfulness, and respect.
iv. Advocate for transparent communication and education on the significance of cultural influences, fostering a collaborative, inclusive, and engaging approach.

6. RECOMMENDATIONS AND CONCLUSION
This journal article presents a comprehensive systematic review encompassing forty-nine articles from 2009 to 2023, delving into the intricate relationship between cultural influences and sustainable housing design. The synthesis, employing a mixed-methods approach, amalgamates descriptive statistics, thematic analysis, and meta-analysis. The article critically examines implications, limitations, and recommendations, encapsulating key findings:

i. Cultural influences play a pivotal role in sustainable housing design, manifesting as barriers, drivers, opportunities, and outcomes.
ii. Positive and moderate effects are discerned across various outcomes, including energy efficiency, indoor air quality, water management, and spatial organization.
iii. Variability in the influence of cultural dimensions, sources, and levels underscores the nuanced nature of these relationships.

iv.   The dynamic and interactive nature of cultural influences necessitates a context-specific, user-oriented approach to sustainable housing design.

Contributions of the systematic review extend across theoretical, practical, and policy domains:
  i.   **Theoretical Contribution:** An all-encompassing overview, gap identification, and future research direction proposals in sustainable housing design and cultural influences.
  ii.   **Practical Contribution:** Practical guidance for stakeholders emphasizes the importance of integrating cultural influences sensitively, responsively, and holistically.
  iii.   **Policy Contribution:** Insights for policy makers and regulators advocate for the development of supportive, inclusive, and responsive policies.

The systematic review acknowledges limitations related to literature, methodology, and context, suggesting future research and practice directions:
  i.   **Future Research:** Encourages studies in underrepresented contexts, diverse methods, improved quality assessment, and exploration of relationship mechanisms.
  ii.   **Future Practice:** Advocates for a context-specific, user-oriented design, continuous evaluation, and transparent communication.

       In conclusion, the article underlines the relevance of cultural influences in sustainable housing design across diverse contexts and regions. It calls for future research and practice to address gaps, explore opportunities, and integrate cultural considerations more effectively, aspiring to inspire and inform subsequent endeavours in this realm.

REFERENCES

[1]   United Nations. (2018). The Sustainable Development Goals Report 2018.
[2]   United Nations. (2015). Transforming our world: The 2030 agenda for sustainable development.
[3]   Raouf, A. M., & Al-Ghamdi, S. G. (2023). Framework to evaluate quality performance of green building delivery: construction and operational stage. International Journal of Construction Management, 23(2), 253-267.
[4]   UN-Habitat. (2016). World Cities Report 2016: Urbanization and Development.
[5]   Almusaed, A., & Almssad, A. (2012). Improvement of thermal insulation by environmental means. Eff. Therm. Insul. Oper. Factor A Passiv. Build. Model, 1.
[6]   Helmrich, A. M., & Chester, M. V. (2022). Reconciling complexity and deep uncertainty in infrastructure design for climate adaptation. Sustainable and Resilient Infrastructure, 7(2), 83-99.
[7]   Manzano-Agugliaro, F., Montoya, F. G., Sabio-Ortega, A., & García-Cruz, A. (2015). Review of bioclimatic architecture strategies for achieving thermal comfort. Renewable and Sustainable Energy Reviews, 49, 736-755.
[8]   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.
[9]   Goubran, S., Walker, T., Cucuzzella, C., & Schwartz, T. (2023). Green building standards and the united nations' sustainable development goals. Journal of Environmental Management, 326, 116552.
[10]   Haapio, A. (2012). Towards sustainable urban communities. Environmental Impact Assessment Review, 32(1), 165-169.
[11]   Sharifi, A., & Murayama, A. (2013). A critical review of seven selected neighborhood sustainability assessment tools. Environmental impact assessment review, 38, 73-87.
[12]   Marzouk, M., Ayman, R., Alwan, Z., & Elshaboury, N. (2022). Green building system integration into project delivery utilising BIM. Environment, Development and Sustainability, 24(5), 6467-6480.
[13]   Agudelo-Vera, C. M., Mels, A. R., Keesman, K. J., & Rijnaarts, H. H. (2011). Resource management as a key factor for sustainable urban planning. Journal of environmental management, 92(10), 2295-2303.
[14]   Hassan, A. M., & Lee, H. (2015). Toward the sustainable development of urban areas: An overview of global trends in trials and policies. Land use policy, 48, 199-212.
[15]   Raouf, A. M., & Al-Ghamdi, S. G. (2021). Framework to evaluate quality performance of green building delivery: project brief and design stage. Buildings, 11(10), 473.
[16]   Hales, R., & Birdthistle, N. (2023). The Sustainable Development Goals–SDG 11 Sustainable Cities and Communities. In Attaining the 2030 Sustainable Development Goal of Sustainable Cities and Communities (pp. 1-9). Emerald Publishing Limited.

[17] GhaffarianHoseini, A., Ibrahim, R., Baharuddin, M. N., & GhaffarianHoseini, A. (2011). Creating green culturally responsive intelligent buildings: Socio-cultural and environmental influences. Intelligent Buildings International, 3(1), 5.

[18] Al Tawayha, F. A. (2019). The influence of the Palestinian sociocultural values in shaping the vernacular sustainable architecture in the old cities of Palestine (Doctoral dissertation, Universidade do Minho (Portugal)).

[19] Almusaed, A. (2010). Biophilic and bioclimatic architecture: analytical therapy for the next generation of passive sustainable architecture. Springer Science & Business Media.

[20] Eller, K. H., Michaels, R., Ruiz-Abou-Nigm, V., & van Loon, H. (2021). SDG 11: Sustainable Cities and Communities. UN Sustainable Development Goals 2030 and the Role of Private International Law, 353-381.

[21] Robinson, D., & Edwards, D. (2009). Sustainable housing design: measurement, motivation, and management in Sutherland Shire, Sydney, Australia. Environment and Planning B: Planning and Design, 36(2), 336-354.

[22] Tabb, P. J., & Deviren, A. S. (2017). The greening of architecture: A critical history and survey of contemporary sustainable architecture and urban design. Routledge.

[23] Gravagnuolo, A., Girard, L. F., Kourtit, K., & Nijkamp, P. (2021). Adaptive re-use of urban cultural resources: Contours of circular city planning. City, Culture and Society, 26, 100416.

[24] Abdel-Azim, G. G., & Osman, K. A. A. (2018). The importance of cultural dimensions in the design process of the vernacular societies. Ain Shams Engineering Journal, 9(4), 2755-2765.

[25] Ordonez-Ponce, E. (2023). The role of local cultural factors in the achievement of the sustainable development goals. Sustainable Development, 31(2), 1122-1134.

[26] Golubchikov, O., & Badyina, A. (2012). Sustainable housing for sustainable cities: a policy framework for developing countries. Nairobi, Kenya: UN-HABITAT.

[27] Lim, R. M. (2016). Cultural sustainability and development: Drukpa and Burman vernacular architecture. In Designing sustainable cities in the developing world (pp. 21-50). Routledge.

[28] Hidalgo Zambrano, R. V., Milanes, C. B., Pérez Montero, O., Mestanza-Ramón, C., Nexar Bolivar, L. O., Cobeña Loor, D., ... & Cuker, B. (2023). A Sustainable Proposal for a Cultural Heritage Declaration in Ecuador: Vernacular Housing of Portoviejo. Sustainability, 15(2), 1115.

[29] Hutchison, A. (2010). Cultural barriers to sustainable design: a case study of the Victa lawnmower in Australia. In Networks of Design: Proceedings of the 2008 Annual International Conference of the Design History Society (UK) (p. 239). Universal-Publishers.

[30] Adabre, M. A., Chan, A. P., & Darko, A. (2022). Interactive effects of institutional, economic, social, and environmental barriers on sustainable housing in a developing country. Building and environment, 207, 108487.

[31] Dias, N., Curwell, S., & Bichard, E. (2014). The current approach of urban design, its implications for sustainable urban development. Procedia Economics and Finance, 18, 497-504.

[32] Duxbury, N., Hosagrahar, J., & Pascual, J. (2016). Why must culture be at the heart of sustainable urban development? Agenda 21 for culture.

[33] Hristova, S., Šešić, M. D., & Duxbury, N. (Eds.). (2015). Culture and sustainability in European cities: Imagining Europolis. Routledge.

[34] Olanipekun, A. O., Xia, B., Hon, C., & Darko, A. (2018). Effect of motivation and owner commitment on the delivery performance of green building projects. Journal of Management in Engineering, 34(1), 04017039.

[35] Næss, P. (2017). Housing culture, residential preferences, and sustainability. Design for a Sustainable Culture, 69-88.

[36] Bocken, N. M., & Geradts, T. H. (2020). Barriers and drivers to sustainable business model innovation: Organization design and dynamic capabilities. Long range planning, 53(4), 101950.

[37] Nematchoua, M. K., Noelson, J. C. V., Saadi, I., Kenfack, H., Andrianaharinjaka, A. Z. F., Ngoumdoum, D. F., ... & Reiter, S. (2020). Application of phase change materials, thermal insulation, and external shading for thermal comfort improvement and cooling energy demand reduction in an office building under different coastal tropical climates. Solar Energy, 207, 458-470.

[38] Gunhan, S. (2019). Analyzing sustainable building construction project delivery practices: builders' perspective. Practice periodical on structural design and construction, 24(1), 05018003.

[39] Jowkar, M., Temeljotov-Salaj, A., Lindkvist, C. M., & Støre-Valen, M. (2022). Sustainable building renovation in residential buildings: barriers and potential motivations in Norwegian culture. Construction management and economics, 40(3), 161-172.

[40] Kagan, S., Hauerwaas, A., Holz, V., & Wedler, P. (2018). Culture in sustainable urban development: Practices and policies for spaces of possibility and institutional innovations. City, Culture and Society, 13, 32-45.

[41] Sacco, P. L., Tavano Blessi, G., & Nuccio, M. (2009). Cultural policies and local planning strategies: What is the role of culture in local sustainable development. J. Arts Mgmt. L. & Soc'y, 39, 45.

[42] Rivero Moreno, L. D. (2020). Sustainable city storytelling: Cultural heritage as a resource for a greener and fairer urban development. Journal of Cultural Heritage Management and Sustainable Development, 10(4), 399-412.

[43] Seyis, S., & Ergen, E. (2017). A decision-making support tool for selecting green building certification credits based on project delivery attributes. Building and Environment, 126, 107-118.

[44] Kibert, C. J. (2016). Sustainable construction: green building design and delivery. John Wiley & Sons.

[45] Ibem, E., & Aduwo, E. (2015). A framework for understanding sustainable housing for policy development and practical actions. In ARCHITECTS COLLOQUIUM, Abuja, Nigeria.

[46] Duxbury, N., Kangas, A., & De Beukelaer, C. (2019). Cultural policies for sustainable development: Four strategic paths. In Cultural Policies for Sustainable Development (pp. 86-102). Routledge.

[47] Zheng, X., Wang, R., Hoekstra, A. Y., Krol, M. S., Zhang, Y., Guo, K., ... & Wang, C. (2021). Consideration of culture is vital if we are to achieve the Sustainable Development Goals. One Earth, 4(2), 307-319.

[48] Oktay, D. (2012). Human sustainable urbanism: In pursuit of ecological and social-cultural sustainability. Procedia-Social and Behavioral Sciences, 36, 16-27.

[49] Ochieng, E. G., Wynn, T. S., Zoufa, T., Ruan, X., Price, A., & Okafor, C. (2014). Integration of sustainability principles into construction project delivery. Architectural Engineering Technology, 3, 1.

[50] Ahern, J. (2013). Urban landscape sustainability and resilience: the promise and challenges of integrating ecology with urban planning and design. Landscape ecology, 28, 1203-1212.

[51] Abed, A., Obeidat, B., & Gharaibeh, I. (2023). The impact of socio-cultural factors on the transformation of house layout: a case of public housing-Zebdeh-Farkouh, in Jordan. Journal of Asian Architecture and Building Engineering, 22(3), 1195-1208.

[52] Wu, S. R., Fan, P., & Chen, J. (2016). Incorporating culture into sustainable development: A cultural sustainability index framework for green buildings. Sustainable Development, 24(1), 64-76.

[53] Awad, J., & Jung, C. (2022). Extracting the planning elements for sustainable urban regeneration in Dubai with AHP (analytic hierarchy process). Sustainable Cities and Society, 76, 103496.

[54] Molenaar, K., Sobin, N., Gransberg, D., McCuen, T., Korkmaz, S., & Horman, M. (2009). Sustainable, high-performance projects and project delivery methods: A state-of-practice report. White Paper for the Design-Build Institute of America and the Charles Pankow Foundation, 1-26.

[55] Kabisch, N., & Haase, D. (2014). Green justice or just green? Provision of urban green spaces in Berlin, Germany. Landscape and urban planning, 122, 129-139.

[56] Ajayi, T. O., Adhuze, O. O., & Adeaga, O. W. (2023). Enhancing Sustainable Housing Practices for Low-Income Communities in Nigeria as a Pathway to Achieve SDG-11. International Journal of Advances in Engineering & Technology, 16(5), 360-375.

[57] Wang, N., & Adeli, H. (2014). Sustainable building design. Journal of civil engineering and management, 20(1), 1-10.

[58] Sandelowski, M., Voils, C. I., & Knafl, G. (2009). On quantitizing. Journal of mixed methods research, 3(3), 208-222.

[59] Clarke, V., & Braun, V. (2017). Thematic analysis. The journal of positive psychology, 12(3), 297-298.