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Integration of Sustainable Architectural Design on Structural Performance of Modern Tropical Urban Buildings

Mashuri
Fakultas Teknik, Universitas Tadulako
Corresponding Author: Mashuri mashuri_hente@untad.ac.id

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A B S T R A C T
The rapid growth of urbanization in tropical regions has increased the need for buildings that not only achieve environmental sustainability but also maintain high structural performance. Sustainable architectural design has emerged as an essential approach for reducing energy consumption, carbon emissions, and resource utilization while enhancing building resilience and efficiency. This study aims to analyze the integration of sustainable architectural design and its influence on the structural performance of modern tropical urban buildings. A Systematic Literature Review (SLR) method following the PRISMA 2020 framework was employed to identify, evaluate, and synthesize relevant studies published between 2015 and 2025. Literature was collected from major scientific databases, and 10 articles meeting the inclusion criteria were selected for qualitative synthesis and thematic analysis. The findings reveal five major themes: integration of structural and environmental performance, material efficiency and embodied carbon reduction, climate-responsive design, building resilience and durability, and computational design optimization. The review demonstrates that sustainable architectural design significantly contributes to improved structural efficiency, enhanced resilience, reduced environmental impact, and long-term building performance. The study highlights the importance of adopting holistic and multidisciplinary design approaches to support the development of sustainable and resilient tropical urban environments.

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INTRODUCTION

The rapid pace of global urbanization has increased the demand for urban buildings that not only fulfill spatial and functional requirements but also demonstrate sustainable environmental and structural performance. The building sector remains one of the largest contributors to global energy consumption and carbon emissions, prompting the adoption of sustainable architectural design approaches aimed at reducing the environmental impacts of the built environment (United Nations Environment Programme [UNEP], 2023; Helal et al., 2024). In contemporary urban contexts, the integration of sustainability principles into architectural design has become increasingly important because buildings are expected to achieve energy efficiency while maintaining safety, comfort, and long-term structural reliability (Angeles et al., 2021; Wang et al., 2024). Consequently, the relationship between sustainable architectural design and structural performance has emerged as a significant area of interest in both academic research and professional construction practices (Bohorquez et al., 2024).

Modern urban buildings located in tropical regions face unique challenges compared to those situated in temperate climates. Tropical environments are characterized by high temperatures, elevated humidity levels, intense solar radiation, and substantial rainfall, all of which require design strategies capable of enhancing energy efficiency while preserving structural integrity (Enggarsiwi et al., 2024; Wang et al., 2024). Passive design strategies, including natural ventilation, building orientation optimization, thermal insulation, and solar heat control through building envelopes, have been widely implemented to improve thermal comfort in tropical buildings (Imjai et al., 2024). However, the application of these strategies can significantly influence structural configurations, load distribution systems, and material selection processes within the building design framework (Imjai et al., 2024; Wang et al., 2024).

Over the past decade, the concept of sustainable architectural design has evolved beyond energy efficiency considerations toward a more holistic approach encompassing embodied carbon reduction, resilience enhancement, and structural performance optimization. This approach emphasizes that architectural decisions related to building form, structural systems, material selection, and spatial organization have direct implications for resource consumption and structural efficiency (Helal et al., 2024; Wang et al., 2024). Previous studies have demonstrated that integrating environmental and structural design objectives can reduce material consumption, lower carbon emissions, and improve operational efficiency without compromising structural safety requirements (Bohorquez et al., 2024; Wang et al., 2024). Therefore, sustainable design integration has become a critical strategy for developing resilient and resource-efficient urban infrastructure.

In addition to environmental considerations, modern urban buildings must withstand a variety of external challenges, including climate change impacts, urban heat island effects, natural hazards, and increasing pressures on energy resources. As a result, structural performance is no longer evaluated solely based on load-bearing capacity but also on its contribution to overall building sustainability (Angeles et al., 2021; Gidaris et al., 2021). The integration of sustainable architectural design with structural systems facilitates the development of more resilient buildings through optimized building forms, efficient material utilization, and reduced environmental impacts throughout the building life cycle (Tsai & Hsu, 2024; Bohorquez et al., 2024). Such an approach is particularly relevant in rapidly developing tropical urban areas where environmental and infrastructural pressures continue to intensify.

LITERATURE REVIEW

The urgency of this study is reinforced by the growing global commitment to sustainable development goals and net-zero carbon building initiatives. Although numerous sustainable design strategies have been implemented in modern tropical buildings, there remains a need to better understand how sustainable architectural elements influence structural performance comprehensively. Existing studies frequently examine environmental performance and structural performance separately, resulting in fragmented design approaches that may not fully address contemporary sustainability challenges (Wang et al., 2024). Consequently, a comprehensive investigation that integrates these two dimensions is essential for developing design frameworks capable of enhancing environmental efficiency while ensuring structural reliability in tropical urban buildings.

Several previous studies have explored the relationship between sustainability and building performance from various perspectives. Wang et al. (2024) reviewed integrated structural-environmental design optimization and concluded that interdisciplinary collaboration remains relatively limited. Bohorquez et al. (2024) found that optimized earthquake-resistant structural systems can significantly reduce carbon emissions without compromising structural performance. Imjai et al. (2024) demonstrated that structural insulated panels improve both thermal comfort and structural capacity in tropical climates. Tsai and Hsu (2024) reported that hybrid timber structures exhibit superior material efficiency compared to conventional structural systems. Furthermore, Helal et al. (2024) emphasized that architectural decisions may substantially affect embodied carbon levels and therefore should be evaluated alongside structural performance criteria. Despite these contributions, studies specifically examining the integration of sustainable architectural design and structural performance in modern tropical urban buildings remain limited, indicating a significant research gap.

Based on the aforementioned discussion, this study aims to analyze the integration of sustainable architectural design and its influence on the structural performance of modern tropical urban buildings. The findings are expected to provide a comprehensive understanding of the relationship between sustainability strategies, environmental efficiency, and structural performance, thereby contributing to the development of more resilient, efficient, and sustainable building design frameworks for future tropical urban environments.

METHODOLOGY

This study employed a Systematic Literature Review (SLR) approach to systematically identify, evaluate, and synthesize existing scientific evidence regarding the integration of sustainable architectural design and its influence on the structural performance of modern tropical urban buildings. The SLR method was selected because it provides a transparent, rigorous, and replicable process for reviewing previous studies, enabling researchers to develop a comprehensive understanding of research trends, theoretical developments, and empirical findings within a specific field of study (Snyder, 2019; Xiao & Watson, 2019).

The review process followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines, which consist of four main stages: identification, screening, eligibility assessment, and inclusion (Page et al., 2021). Literature searches were conducted across several international scientific databases, including Scopus, ScienceDirect, Web of Science, SpringerLink, and Google Scholar. The search process was carried out between January and February 2026, focusing on publications published between 2015 and 2025 to ensure the inclusion of recent and relevant studies.

The search strategy utilized a combination of keywords related to sustainable architecture and structural engineering. The primary search terms included "sustainable architectural design," "sustainable building design," "structural performance," "building structural efficiency," "tropical architecture," "urban buildings," "green building," "building sustainability," "resilient building design," and "structural sustainability." These keywords were combined using Boolean operators (AND, OR) to maximize the retrieval of relevant literature. Examples of search strings included ("sustainable architectural design" AND "structural performance"), ("green building" AND "tropical architecture"), and ("building sustainability" AND "urban buildings" AND "structural systems").

To ensure the relevance and quality of the reviewed studies, inclusion criteria were established as follows: (1) articles published in peer-reviewed international journals; (2) publications released between 2015 and 2025; (3) studies written in English; (4) research focusing on sustainable architectural design, structural performance, tropical buildings, urban buildings, or the integration of environmental and structural considerations; and (5) availability of full-text articles. Exclusion criteria included duplicate records, conference abstracts without full papers, editorials, book reviews, non-scientific publications, and studies that discussed sustainability or energy efficiency without addressing structural performance aspects.

The initial database search identified 186 publications. After removing 38 duplicate records, 148 articles remained for title and abstract screening. During the screening stage, 102 studies were excluded because they were not directly related to the integration of sustainable architectural design and structural performance. Subsequently, 46 articles underwent full-text eligibility assessment. Based on the predefined inclusion and exclusion criteria, 36 studies were excluded due to insufficient relevance, lack of methodological clarity, or absence of discussion concerning structural performance. As a result, 10 articles met all eligibility requirements and were included in the final review and synthesis process.

To enhance the reliability of the review, a quality assessment procedure was conducted for each selected article. The evaluation considered several aspects, including research objectives, methodological rigor, data validity, relevance to the research topic, and contribution to the field. Only studies demonstrating sufficient methodological quality and direct relevance to the research objectives were retained for analysis (Kitchenham & Charters, 2007).

Data extraction was performed using a structured review matrix that recorded information such as authors, publication year, country of study, research objectives, methodologies, sustainability dimensions, structural performance indicators, and key findings. The extracted data were subsequently analyzed using thematic analysis, allowing the identification of recurring patterns, concepts, and relationships across the selected studies (Braun & Clarke, 2022). The themes generated from the analysis included sustainable design strategies, material efficiency, structural resilience, environmental performance, and integrated building design approaches in tropical urban environments.

Finally, the findings were synthesized through a narrative approach to provide a comprehensive overview of how sustainable architectural design contributes to structural performance in modern tropical urban buildings. The synthesis also enabled the identification of existing research gaps and future research opportunities, thereby contributing to the advancement of knowledge in sustainable architecture and structural engineering.

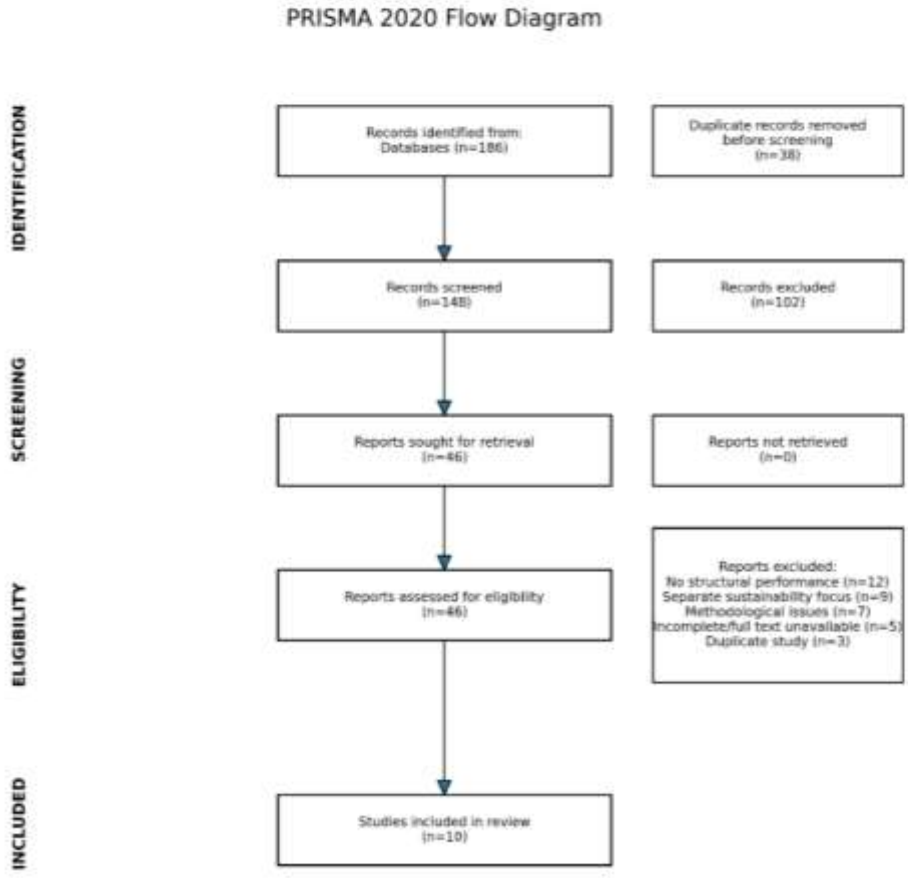

Figure 1. PRISMA 2020 Flow Diagram

RESEARCH RESULTS

Based on the PRISMA 2020 screening process, a total of 10 articles met the inclusion criteria and were selected for qualitative synthesis. The selected studies were published between 2021 and 2025 and originated from various countries and research contexts. These studies collectively examined the relationship between sustainable architectural design, environmental performance, material efficiency, structural resilience, and building sustainability in urban and tropical environments. The selected literature demonstrates a growing interdisciplinary interest in integrating architectural sustainability principles with structural engineering considerations to achieve high-performance buildings.

Table 1. Characteristics and Main Findings of Selected Studies

No	Author(s)	Year	Title	Method	Main Findings
1	Wang, Akbarzadeh, & Aviv	2024	Multi-objective Design Exploration for Integrated Structural-Environmental Performance of Buildings: A Review	Systematic Review	Integration of environmental and structural objectives improves building sustainability and material efficiency.
2	Helal et al.	2024	Embodied Carbon Premium for Cantilevers	Quantitative Analysis	Architectural design decisions significantly influence embodied carbon and structural efficiency.
3	Bohorquez et al.	2024	Environmental Impact of Earthquake-Resistant Design	Life Cycle Assessment	Seismic-resistant structures can reduce environmental impacts when optimized during design stages.
4	Imjai et al.	2024	Performance of a Novel Structural Insulated Panel in	Experimental Study	Structural insulated panels improve thermal performance and maintain

			Tropical Climates		structural capacity in tropical conditions.
5	Tsai & Hsu	2024	Assessment of Structural Performance, Materials Efficiency, and Environmental Impact of Multi-Story Hybrid Timber Structures	Comparative Analysis	Hybrid timber structures exhibit superior material efficiency and reduced carbon emissions.
6	Gidaris, Taflanidis, & Liel	2021	Structural Performance-Based Environmental Impact Assessment Framework	Framework Development	Structural performance and environmental impact should be assessed simultaneously.
7	Angeles et al.	2021	Advancing the Design of Resilient and Sustainable Buildings	Life-Cycle Analysis	Resilient structural systems contribute to long-term sustainability outcomes.
8	Wang et al.	2024	Key Issues and Solutions in Tropical Islands Zero Carbon Buildings	Review Study	Passive design strategies improve building sustainability in tropical climates.
9	Maksoud et al.	2024	Computational Design for Sustainable Flood-Resilient Urban Habitats	Computational Simulation	Sustainable urban design enhances resilience against environmental hazards.
10	Lehmann & Manshour	2025	Passive Cooling Strategies Integrating	Systematic Review	Passive cooling design significantly reduces energy

			Traditional Wisdom and Modern Innovations		consumption and improves building sustainability.

The selected studies indicate that sustainable architectural design is increasingly being integrated with structural engineering objectives. Most studies emphasize the importance of balancing environmental performance, material efficiency, resilience, and structural safety. Furthermore, several studies specifically highlight the significance of passive design strategies and innovative materials in tropical climates, where thermal performance and structural durability are critical factors. These findings suggest that sustainable architectural design contributes not only to environmental goals but also to enhanced structural performance and long-term building resilience.

Based on the thematic analysis of the 10 selected articles, five major themes were identified that explain the relationship between sustainable architectural design and the structural performance of modern tropical urban buildings. These themes include: (1) the integration of structural and environmental performance, (2) material efficiency and embodied carbon reduction, (3) climate-responsive design in tropical environments, (4) building resilience and structural durability, and (5) computational design and multidisciplinary optimization. Collectively, these themes demonstrate that sustainability in contemporary architecture is no longer viewed as a separate concern from structural engineering but rather as an integrated system aimed at creating buildings that are efficient, safe, resilient, and environmentally sustainable.

Integration of Structural and Environmental Performance

The most prominent theme identified in the literature is the integration of structural performance and environmental performance. Most studies emphasize that modern building design should simultaneously consider both aspects from the earliest stages of the design process. Wang et al. (2024) argued that conventional design approaches often separate environmental and structural considerations, leading to suboptimal outcomes. Therefore, multi-objective design approaches are increasingly recommended because they enable the simultaneous evaluation of energy efficiency, material consumption, and structural safety.

Similar findings were reported by Gidaris et al. (2021), who developed a framework that integrates structural performance assessment with environmental impact evaluation. Their study demonstrated that structural design decisions directly influence carbon emissions, resource consumption, and building resilience throughout the life cycle. Likewise, Angeles et al. (2021) emphasized that buildings designed with both resilience and sustainability objectives achieve superior overall performance compared to buildings focusing on only one of these dimensions.

The synthesis of the reviewed studies indicates that the integration of environmental and structural objectives has become a fundamental principle in the development of modern tropical urban buildings. Such an approach enables buildings to achieve not only higher energy efficiency but also improved long-term structural performance and sustainability.

Material Efficiency and Embodied Carbon Reduction

The second major theme concerns material efficiency and the reduction of embodied carbon. Several studies demonstrate that material selection plays a crucial role in determining both the environmental sustainability and structural performance of buildings. Helal et al. (2024) found that certain architectural decisions, such as excessive cantilever utilization, significantly increase embodied carbon due to the additional structural materials required to maintain stability and safety.

Tsai and Hsu (2024) reported that hybrid timber structural systems exhibit greater material efficiency than conventional concrete and steel structures. In addition to reducing carbon emissions, hybrid timber systems demonstrated competitive structural performance in regions exposed to high seismic risks. These findings suggest that material innovation can serve as an effective strategy for achieving both sustainability and structural reliability.

Similarly, Bohorquez et al. (2024) revealed that optimizing earthquake-resistant structural systems can substantially reduce environmental impacts without compromising building safety. Overall, the literature indicates that material efficiency contributes not only to environmental sustainability but also to structural optimization and construction cost reduction.

Climate-Responsive Design in Tropical Urban Buildings

The third theme emerging from the literature is the importance of climate-responsive design in tropical urban environments. Tropical regions are characterized by high temperatures, elevated humidity levels, and intense solar radiation, requiring building strategies that differ significantly from those applied in temperate climates.

Wang et al. (2024) highlighted that achieving low-carbon buildings in tropical regions requires the implementation of passive design strategies, including optimized building orientation, natural ventilation systems, and climate-responsive building envelopes. Likewise, Imjai et al. (2024) demonstrated that structural insulated panels improve thermal comfort while maintaining adequate structural capacity under tropical climatic conditions.

Furthermore, Lehmann and Manshour (2025) found that integrating traditional passive cooling strategies with modern technological innovations can significantly reduce energy consumption while maintaining indoor environmental quality. These findings suggest that climate-responsive design contributes not only to thermal comfort but also to operational efficiency and structural durability, making it a critical component of sustainable tropical architecture.

Building Resilience and Structural Durability

The fourth theme focuses on enhancing building resilience and structural durability in response to environmental challenges. Climate change, increasing urbanization, and the growing frequency of natural disasters have intensified the need for buildings capable of adapting to dynamic and uncertain conditions.

Angeles et al. (2021) demonstrated that buildings integrating sustainability and resilience principles are better able to maintain operational functionality following external disturbances. Similarly, Bohorquez et al. (2024) concluded that optimized earthquake-resistant structural systems enhance safety while simultaneously reducing environmental impacts throughout the building life cycle.

In addition, Maksoud et al. (2024) showed that computationally driven sustainable urban design strategies can improve building resilience against flooding and climate-related risks. The collective findings indicate that sustainability and resilience are complementary concepts that jointly contribute to the development of safer and more durable tropical urban buildings.

Computational Design and Multidisciplinary Optimization

The final theme identified in the literature is the increasing use of computational technologies and multidisciplinary approaches in building design. Advances in digital technologies have enabled architects and engineers to evaluate multiple design alternatives simultaneously based on various performance indicators.

Wang et al. (2024) emphasized that multi-objective optimization techniques facilitate the integration of environmental and structural parameters within a unified design framework. Such approaches support more informed decision-making processes by balancing energy efficiency, material utilization, and structural safety requirements.

Similarly, Maksoud et al. (2024) demonstrated that parametric design and computational simulations can generate building forms that are more adaptive to environmental conditions while simultaneously improving structural performance. These findings indicate that digital technologies play an increasingly important role in supporting the implementation of sustainable architectural design in modern urban buildings.

Overall, the thematic analysis reveals that the integration of sustainable architectural design and structural performance has become a rapidly evolving area of research and professional practice. The five identified themes demonstrate that sustainability extends beyond reducing energy consumption and carbon emissions to encompass material efficiency, structural resilience, climate responsiveness, and technological innovation. Consequently, the development of modern tropical urban buildings requires a holistic and multidisciplinary design approach capable of balancing environmental performance, structural safety, and long-term sustainability.

The thematic findings also indicate that future building design practices should prioritize the integration of environmental and structural considerations from the earliest stages of planning and design. Such integration is essential for achieving resilient, resource-efficient, and sustainable urban environments. Furthermore, these themes provide the foundation for the subsequent **Discussion** section, which examines the implications of the findings in relation to existing theories, previous research, and future research directions.

DISCUSSION

The findings of this systematic literature review demonstrate that the integration of sustainable architectural design and structural performance has become a critical paradigm in the development of modern tropical urban buildings. The thematic analysis identified five interconnected themes: integration of structural and environmental performance, material efficiency and embodied carbon reduction, climate-responsive design, building resilience and durability, and computational design optimization. These findings indicate a shift from traditional building design approaches, which often treat sustainability and structural engineering as separate disciplines, toward a more holistic framework that simultaneously addresses environmental, structural, and operational objectives.

One of the most significant findings is the growing emphasis on integrating structural and environmental performance throughout the building design process. The reviewed studies consistently indicate that environmental sustainability cannot be achieved solely through energy-efficient technologies or renewable energy systems; rather, it must be embedded within the structural and architectural configuration of the building itself. This finding aligns with the principles of integrated design theory, which emphasize collaboration among architects, structural engineers, and sustainability specialists from the earliest design stages (Wang et al., 2024). The integration of environmental and structural objectives enables designers to optimize resource consumption, reduce environmental impacts, and enhance building performance over the entire life cycle. Consequently, sustainable architecture should be viewed not merely as an environmental strategy but as a comprehensive design philosophy that incorporates structural considerations as a core component.

Another important finding concerns the role of material efficiency and embodied carbon reduction in achieving sustainable building performance. The reviewed literature reveals that material selection significantly influences both structural performance and environmental outcomes. Conventional construction materials such as reinforced concrete and steel provide high structural capacity but are associated with substantial embodied carbon emissions. In contrast, emerging alternatives such as hybrid timber systems and optimized structural configurations offer opportunities to reduce carbon footprints while maintaining structural reliability (Tsai & Hsu, 2024; Helal et al., 2024). These findings support life-cycle assessment (LCA) perspectives, which argue that sustainability should be evaluated across the entire life span of a building rather than solely during the operational phase. Therefore, future building design should prioritize low-carbon materials and resource-efficient structural systems to support global decarbonization goals within the construction sector.

The findings also highlight the importance of climate-responsive architectural design in tropical urban environments. Tropical regions experience unique climatic conditions characterized by high temperatures, elevated humidity levels, intense solar radiation, and seasonal rainfall patterns. The reviewed studies demonstrate that passive design strategies—including natural ventilation, shading systems, optimized building orientation, and high-performance building envelopes—can significantly improve thermal comfort and energy efficiency while supporting structural functionality. These results reinforce the principles of bioclimatic architecture, which advocate adapting building form and performance to local environmental conditions rather than relying excessively on mechanical systems. In the context of rapidly urbanizing tropical cities, climate-responsive design represents a practical and sustainable approach to reducing energy consumption while enhancing occupant comfort and building durability.

A further contribution of this review is the recognition of resilience as a central component of sustainable building performance. Traditionally, sustainability and resilience have been examined as separate concepts; however, the reviewed studies suggest that both dimensions are increasingly interconnected. Sustainable buildings are expected not only to minimize environmental impacts but also to maintain functionality under adverse conditions such as earthquakes, floods, extreme weather events, and climate-related disruptions. The findings of Angeles et al. (2021), Bohorquez et al. (2024), and Maksoud et al. (2024) indicate that resilient structural systems contribute significantly to long-term sustainability by reducing maintenance requirements, extending service life, and minimizing reconstruction needs following disasters. This finding supports the growing consensus that resilience should be incorporated into sustainability frameworks, particularly in tropical urban areas where environmental risks are becoming increasingly severe due to climate change.

The review further reveals the growing influence of computational technologies and multidisciplinary optimization methods in sustainable building design. Advances in digital tools, parametric modeling, artificial intelligence, and simulation-based optimization have transformed the way architects and engineers evaluate building performance. Rather than relying on sequential decision-making processes, designers can now simultaneously assess multiple performance indicators, including energy consumption, structural efficiency, environmental impact, and occupant comfort. This capability facilitates the development of more informed and balanced design solutions. The findings suggest that computational design methodologies are becoming essential instruments for achieving integrated sustainability objectives, particularly in complex urban environments where multiple performance criteria must be satisfied simultaneously.

Despite the significant progress identified in the literature, several research gaps remain. First, most existing studies focus on either environmental performance or structural performance, with relatively few investigations examining both dimensions through fully integrated analytical frameworks.

Second, empirical studies specifically addressing tropical urban buildings remain limited compared with research conducted in temperate regions. Given the distinctive environmental challenges faced by tropical cities, additional context-specific investigations are needed to develop design solutions that are both regionally appropriate and globally relevant. Third, while computational optimization techniques are increasingly applied, there remains a lack of standardized methodologies for evaluating the combined impacts of architectural, structural, and environmental decisions throughout the building life cycle. Addressing these gaps would contribute to a more comprehensive understanding of sustainable building performance.

From a practical perspective, the findings have important implications for architects, engineers, urban planners, and policymakers. The integration of sustainability and structural performance should be encouraged through interdisciplinary collaboration during all phases of building development. Regulatory frameworks and building standards should also evolve to incorporate both environmental and structural performance indicators rather than treating them as separate assessment categories. Furthermore, the adoption of innovative materials, passive design strategies, and computational optimization tools can support the development of buildings that are not only environmentally responsible but also structurally resilient and economically efficient.

Overall, this review confirms that sustainable architectural design and structural performance are mutually reinforcing dimensions of contemporary building development. The successful integration of these dimensions contributes to reduced environmental impacts, enhanced resource efficiency, improved resilience, and superior long-term building performance. As urbanization continues to accelerate across tropical regions, adopting integrated design approaches will be essential for creating sustainable and resilient urban environments capable of addressing future environmental, social, and infrastructural challenges. Consequently, future research should focus on developing comprehensive frameworks that bridge architecture, structural engineering, environmental science, and digital technology to advance the next generation of sustainable tropical urban buildings.

CONCLUSION AND RECOMMENDATIONS

This systematic literature review confirms that the integration of sustainable architectural design and structural performance is essential for the development of modern tropical urban buildings. The analysis of ten selected studies identified five key themes: the integration of structural and environmental performance, material efficiency and embodied carbon reduction, climate-responsive design, building resilience and durability, and computational design optimization. These themes demonstrate that sustainability and structural engineering should no longer be treated as separate disciplines but rather as interconnected components of a comprehensive building design framework.

The findings indicate that sustainable architectural strategies, including passive design approaches, innovative low-carbon materials, resilient structural systems, and digital optimization technologies, can simultaneously improve environmental performance and structural reliability. In tropical urban environments, climate-responsive design plays a particularly important role in enhancing thermal comfort, reducing energy consumption, and maintaining long-term structural durability. Furthermore, the integration of resilience principles strengthens building adaptability to climate-related risks and natural hazards.

ADVANCED RESEARCH

Overall, sustainable architectural design and structural performance are mutually reinforcing dimensions that contribute to reduced environmental impacts, improved resource efficiency, enhanced resilience, and superior long-term building performance. Future research should focus on developing integrated frameworks that combine architecture, structural engineering, environmental science, and digital technologies to support the next generation of sustainable tropical urban buildings.

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