Towards Creating Sustainable High-Rise Buildings in Ho Chi Minh City, Vietnam: Lessons from Traditional Building Design Principles

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Abstract

In the context of global climate change, Vietnam is facing significant challenges in achieving sustainable development goals, particularly those related to carbon neutrality in the construction sector. Modern high-rise buildings in Ho Chi Minh City (HCMC) contribute substantially to greenhouse gas emissions due to their reliance on artificial cooling systems and imported materials. In comparison, vernacular architecture of Vietnam has long embodied passive design principles—natural ventilation, shading, the use of local materials, and adaptation to tropical climates, which are effective low-energy techniques which have produced sustainable buildings for centuries. In this context, this paper examines how these traditional principles can inform sustainable design strategies for contemporary high-rise buildings in HCMC.

The research adopts a qualitative methodology, involving a literature survey and consultation of experts through interviews. These are supported with global case studies alongside Vietnamese case studies on climate-responsive dwellings employing passive design strategies in vernacular architecture.

The findings reveal that integrating vernacular wisdom into modern constructions could enhance thermal comfort, reduce energy demand, and support a low-carbon transition. The paper thus concludes that vernacular heritage offers a rich source of sustainable knowledge applicable to modern sustainable architecture. Learning from traditional design logic—orientation, material use, cross-ventilation, and community layout—can help cities like HCMC to develop high-rise buildings that are both technologically advanced and environmentally rooted in local culture.

Keywords: Vernacular architecture, Passive design, Sustainable building, Net Zero Carbon, Ho Chi Minh City, Vietnam

Introduction

Ho Chi Minh City (HCMC), Vietnam's largest and fastest-growing metropolis, is undergoing rapid urbanization and vertical expansion as a response to population growth, land scarcity, and rising housing demand. However, the high-rise residential developments of the city often adopt sealed, air-conditioned building models that are poorly adapted to the hot-humid tropical climate. As cooling energy demand continues to rise, the built environment has

become a major contributor to carbon emissions, posing significant challenges to national commitment of Vietnam in achieving Net Zero tatus by 2050 as expected (Ha et al., 2022). These issues underscore the need for alternative design approaches that could reduce energy dependence while enhancing environmental and social resilience.

In this context, vernacular architecture is seen to offer a significant, yet an under-utilized, reservoir of climatic knowledge that can inform contemporary sustainable and Net Zero-oriented design. As Oliver (1997) and Pham (2024) point out, traditional Vietnamese dwellings have long employed passive environmental strategies—natural ventilation, shading layers, porous envelopes, transitional spaces, and the use of local materials—to achieve human comfort without mechanical systems. While these principles have been widely acknowledged in rural or low-rise contexts, their potential application in high-rise residential architecture in HCMC remains underexplored. This gap is particularly important because high-rise typologies now shape the thermal landscape, energy consumption patterns, and quality of life of the city.

In fact, current studies on sustainable high-rise housing tend to focus on technological solutions such as advanced glazing, mechanical systems, or energy-efficient equipment. Meanwhile, research on vernacular design primarily addresses heritage preservation or low-rise settlements. Few attempts have been made to bridge these two domains or re-interpret vernacular environmental intelligence for vertical architecture in tropical megacities (Lim & Tan, 2023). As a result, an opportunity exists to re-position vernacular principles as a strategic foundation for achieving low-carbon, climate-responsive high-rise development.

Therefore, this paper investigates how vernacular architectural principles can inform sustainable high-rise residential design. The aim is to explore how lessons derived from Vietnamese vernacular architecture can contribute to sustainable design of high-rise residential buildings in Ho Chi Minh City. Its objectives are as follows.

1. To identify key vernacular environmental strategies relevant to tropical climate adaptation.
2. To analyse the limitations of current high-rise developments in HCMC regarding energy and climatic performance.
3. To develop hybrid design principles that reinterpret vernacular wisdom for contemporary high-rise applications.
4. To demonstrate the potential of vernacular-inspired strategies to support Net Zero goals in HCMC.

Theoretical Framework

As this research that deals with vernacular architecture for sustainable and net zero energy high-rise building design in Ho Chi Minh City, Vietnam, it is founded on a number of significant theoretical concepts. It thus warrants defining the meanings of these terms as well as the relationships established among them by the erudite theoreticians and scholars, which will generate a theoretical foundation.

Vernacular Architecture

Vernacular architecture refers to the built forms that emerge from local cultural practices, climate, materials, and socio-economic conditions. It is not a stylistic tradition but a dynamic system of environmental adaptation shaped over generations (Oliver, 1997). In Vietnam, vernacular dwellings such as the wooden houses, cottages and three-room houses exhibit common principles: porous envelopes, deep overhangs, extensive shading, cross-ventilation, semi-open transitional spaces, and the use of locally sourced materials. These design characteristics reflect an intimate understanding of the tropical monsoon climate and embody a low-energy, climate-responsive architectural logic (Pham, 2024). Vernacular architecture thus provides a body of indigenous knowledge highly relevant to sustainability.

Sustainability in Architecture

Sustainability in architecture concerns the minimisation of environmental impacts across the building life cycle, including reductions in operational energy, embodied carbon, and ecological footprint. It involves strategies such as passive cooling, green infrastructure, resource-efficient materials, and social well-being (Nguyen & Le, 2023). In tropical megacities, sustainability also emphasises resilience to heat stress, air pollution, and climate-change-induced extreme weather. The principles observed in vernacular buildings—thermal comfort through natural means, efficient material use, and integration with Nature—align closely with contemporary sustainability goals, demonstrating the continuing relevance of traditional environmental knowledge.

Net Zero Design

Net Zero design aims to reduce carbon emissions of a building to balance the amount produced and removed through mitigation strategies. This includes reducing operational energy through passive design, improving insulation and envelope performance, and adopting renewable energy systems, while also lowering embodied carbon through material choices (Ha et al., 2022; Pham & Tan, 2025). For hot-humid climates, effective natural ventilation, shading, and thermal buffering are key components of Net Zero energy performance. Vernacular strategies inherently reduce cooling loads, suggesting their potential to support Net Zero pathways in dense urban conditions.

High-Rise Residential Architecture

High-rise residential buildings are vertical housing types designed to accommodate high-density populations within limited urban land. However, modern high-rise developments in tropical climates often rely heavily on mechanical ventilation and air conditioning, contributing significantly to energy consumption and greenhouse gas emissions (Nguyen & Tran, 2023). Their sealed façades, deep floor plates, and uniform layouts contrast sharply with the adaptive, breathable nature of vernacular buildings. Thus, the challenge lies in integrating passive environmental principles into vertical structures while addressing constraints related to height, wind patterns, fire safety, and socio-cultural expectations.

An Integrative Perspective

When viewed together, these four concepts reveal a compelling theoretical synergy. Vernacular architecture provides climate-adaptive principles; sustainability frames the environmental objectives; Net Zero design establishes performance benchmarks; and high-rise architecture defines the contemporary spatial and urban context. Reinterpreting vernacular strategies within this multi-layered framework offers a pathway to reduce energy dependence, enhance thermal comfort, that could create culturally resonant high-rise environments for Ho Chi Minh City. This theoretical foundation guides the subsequent analysis and development of hybrid design principles presented in this study.

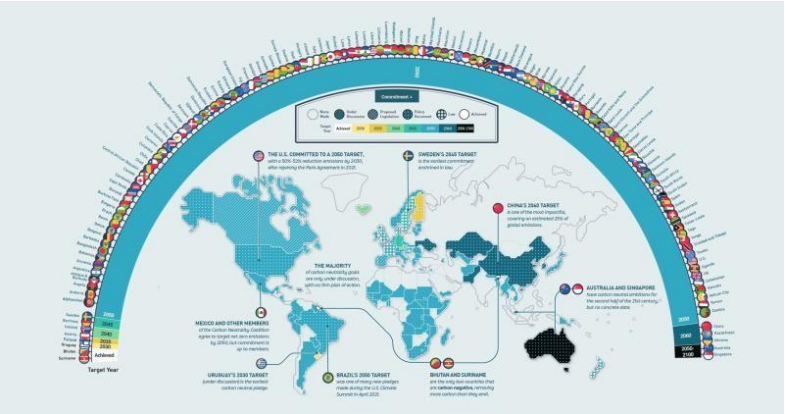

Fig 1: Timeline of Net-Zero Targets of Countries Around the World
Source: https://vertzero.eco/en/insights/vietnamese-businesses-enter-the-race-to-net-zero-by-2050, 2025

Theoretical Background: Vernacular Sustainability

Vernacular Architecture as Sustainable Heritage

Vernacular architecture represents a collective environmental intelligence developed through generations. As noted by Oliver (1997), it reflects "people's adaptation to their environment using locally available resources." In tropical Asia, traditional dwellings were designed to achieve natural thermal comfort through passive means—orientation, ventilation, and shading (Lim & Tan, 2023). In Vietnam, houses in the Mekong Delta and Central Highlands demonstrate this principle through elevated floors, open facades, and lightweight structures that allow air to circulate freely.

Sustainability embedded in vernacular architecture lies not only in materials and techniques but also in its *philosophy of sufficiency*: building just enough for comfort, using what is available, and maintaining a balanced relationship with Nature (Rapoport, 1969). This ecological mindset resonates strongly with today's sustainability goals, which advocate minimizing embodied and operational carbon.

Fig 2: Traditional Vietnamese house (Source: https://www.vietnamairlines.com/hk/en/useful-information/travel-guide/traditional-vietnamese-house, 2025)

Review of Literature

This research employs an examination of previous published research as a research methodology. Hence, it does not engage in the production of a review of literature as is classically done and should be done in any research in order to establish

the status of current knowledge and where the gaps of that knowledge exist. However, following review is useful as a background to this study.

Vernacular Architecture and Climatic Adaptation

Foundational works such as Oliver (1997) and Rapoport (1969) highlight the intrinsic adaptability of vernacular buildings to their local climates. They argue that vernacular forms emerge as cumulative responses to environmental, socio-cultural, and material conditions rather than stylistic choices. In the context of Southeast Asia, recent studies emphasise passive environmental performance, including natural ventilation, shading layers, and transitional spaces as defining features of tropical vernacular dwellings (Lim & Tan, 2023; Pham, 2024). These studies confirm the environmental intelligence embedded in vernacular traditions; however, most focus on rural or low-rise settlements and do not articulate pathways for applying these principles to vertical urban housing.

Sustainability and Green Design in Tropical Contexts

The literature on sustainable architecture underscores strategies such as green envelopes, daylighting, passive cooling, and bioclimatic design as tools for reducing energy consumption in tropical regions (Nguyen & Le, 2023; Sujono et al., 2023). These studies provide strong empirical evidence of how green infrastructure mitigates urban heat island effects and improves thermal comfort. Nevertheless, the majority of this research is limited to standalone buildings or small-scale developments. Only a few studies consider how sustainability principles can be integrated into large-scale urban housing typologies or dense high-rise environments, which present additional structural, regulatory, and microclimatic challenges.

Net Zero Frameworks and Material Decarbonisation

Growing global commitments toward Net Zero Carbon have stimulated research on low-energy building systems, renewable energy integration, and embodied carbon reduction. Scholars such as Ha et al. (2022) and Pham & Tan (2025) highlight the importance of combining operational energy reduction with low-carbon materials and construction practices. Although these frameworks provide essential guidance, they tend to prioritise technological and engineering solutions. Few studies explore how cultural and vernacular-based strategies can contribute to Net Zero pathways, particularly in tropical megacities like Ho Chi Minh City where cooling loads dominate total energy use.

High-Rise Residential Challenges in Ho Chi Minh City

Recent urban studies document the rapid expansion of high-rise housing in Ho Chi Minh City and the corresponding increase in energy demand, heat island intensity, and indoor comfort challenges (Nguyen & Tran, 2023; Vo et al., 2024). These studies point out systemic issues such as sealed façades, reliance on air conditioning, insufficient shading, and limited natural ventilation. While they identify environmental shortcomings, they do not propose culturally grounded or climate-adaptive design frameworks. Furthermore, most existing research frames high-rise architecture primarily through planning or technological lenses rather than vernacular or heritage-based perspectives.

Research Gap

Across these bodies of literature, three major gaps exist.

1. A lack of research connecting vernacular environmental principles with high-rise residential design, especially in tropical megacities.
2. An absence of integrative frameworks that combine vernacular wisdom, sustainability strategies, and Net Zero carbon objectives within vertical urban environments.
3. Limited exploration of how culturally embedded passive strategies can address the energy and comfort challenges of contemporary high-rise living in Ho Chi Minh City.

This study seeks to address these gaps by synthesising vernacular climatic knowledge with modern performance-based design strategies to propose a hybridised approach for sustainable high-rise developments in Ho Chi Minh City.

Research Methodology

This study adopts a qualitative research methodology that integrates literature analysis, contextual examination, and case-based interpretation to investigate how vernacular architectural principles can support sustainable high-rise residential design in Ho Chi Minh City. Given the complexity of tropical climatic conditions and the socio-cultural dimensions of vernacular architecture, a qualitative approach provides the depth and flexibility needed to interpret environmental strategies within their broader cultural and urban contexts.

Findings

Lessons from Global Vernacular Practices

Internationally, several studies highlight the relevance of vernacular knowledge for modern sustainability. In India, passive cooling strategies in courtyard houses have informed contemporary energy-efficient housing prototypes (Kumar & Devi, 2024). In Indonesia and Thailand, the reintroduction of shading devices derived from traditional architecture has significantly reduced building energy loads (Sujono et al., 2023). Similarly, in the Middle East, wind towers and mashrabiya screens are being reinterpreted through modern materials to enhance indoor air quality.

These examples suggest that the *vernacular approach*—understanding climate, materials, and social patterns—is not merely nostalgic but strategic. It provides architects with climate-responsive design principles that are inherently low-carbon and culturally resilient.

The Case of Ho Chi Minh City

Climatic Context and Urban Challenges

Ho Chi Minh City (HCMC) is located in a humid tropical monsoon climate characterized by consistently high temperatures (27–28°C), strong solar radiation, high humidity and seasonal heavy rainfall. The rapid urbanization of the city over the past two decades has resulted in significant increases in built density, reduced green areas, and expanded impermeable surfaces. Recent studies show that the urban heat island effect has intensified, with central districts recording temperatures 1.5–2°C higher than suburban areas (Vo et al., 2024). These climatic pressures pose substantial challenges to maintaining thermal comfort in modern high-rise buildings.

The proliferation of high-rise residential developments has been driven by population growth and land scarcity. However, many of these buildings rely heavily on mechanical air-conditioning due to poor passive design strategies and limited natural ventilation. Energy consumption for cooling represents 45–60% of total household electricity used in typical high-rise apartments (Nguyen & Tran, 2023). High-rise blocks built with extensive glass Facades,

minimal external shading, and sealed corridors prevent effective cross-ventilation and exacerbate heat gain. This imported design model—derived from temperate climates—disregards the environmental realities of HCMC and leads to increased energy demand and a higher carbon footprint.

Moreover, the reduction of natural airflow caused by dense clusters of tall buildings limits the cooling capacity of prevailing winds. The increasing use of heat-absorbing materials such as concrete and glass further contributes to microclimatic degradation. These issues underscore the need to rethink high-rise housing design in HCMC through strategies that restore climatic responsiveness and incorporate principles proven effective in Vietnamese vernacular architecture.

Existing High-Rise Development and Its Limitations

The existing stock of high-rise buildings in HCMC reveals two major limitations: inadequate energy performance and insufficient adaptation to local climatic conditions.

1) Energy inefficiency

Most contemporary high-rise projects follow a "sealed tower" typology with fully enclosed corridors and large curtain-wall Facades. This approach results in:

- Increased solar heat gain and higher cooling loads,
- Restricted natural ventilation, especially at lower and mid-level floors,
- Dependence on mechanical systems for both thermal comfort and air circulation.

Comparative studies show that apartments designed with cross-ventilation can reduce cooling energy by 20–30%, yet this feature is often absent in current developments.

2) Climatic mismatch and loss of local identity

Vietnamese vernacular dwellings—such as open timber houses, stilt houses, and courtyard-based layouts—traditionally emphasized shading, airflow, and lightweight breathable materials. In contrast, modern high-rise buildings adopt heavy, airtight envelopes and lack the transitional spaces (verandas, overhangs, semi-open rooms) that historically moderated heat and humidity. The absence of buffer zones or permeable Facades disregards centuries of proven climatic adaptation (Pham, 2024; Oliver, 1997).

3) Implications for sustainable and Net Zero design

If high-rise construction continues to follow the "high-density, sealed, mechanically cooled" model, achieving Net Zero goals by 2050 will remain a critical challenge for HCMC. Alternatively, integrating vernacular principles—such as porosity, shading depth, cross-ventilation, and climatically adaptive materials—into high-rise design could:

- Reduce operational energy by 25–40%,
- Enhance indoor environmental quality,
- Increase resilience to climate change,
- And reinforce cultural identity within the modern urban landscape.

For these reasons, vernacular architecture provides not only historical reference but a strategic foundation for the development of sustainable, climate-responsive, and Net Zero high-rise buildings in Ho Chi Minh City.

Design Lessons and Hybrid Solutions

Reinterpreting Vernacular Principles for High-Rise Architecture

According to Oliver (1997), vernacular architecture embodies adaptive strategies that respond directly to local climate, materials, and socio-cultural practices. In Vietnam, traditional dwellings consistently incorporate passive design principles such as cross-ventilation, shaded envelopes, deep eaves, and porous wall systems, which collectively help reduce heat gain and enhance thermal comfort without mechanical cooling. These characteristics are well documented in scholarly analyses of Vietnamese climate-adaptive housing (Pham, 2024), demonstrating how vernacular spatial logic is inherently aligned with the demands of a hot-humid tropical environment.

Fig 3: The Stilt House reflects the harmony between humans and nature (Source: https://www.vietnamairlines.com/hk/en/useful-information/travel-guide/traditional-vietnamese-house, 2025)

When compared with the climatic conditions of Ho Chi Minh City—characterised by high humidity, increasing urban heat island intensity, and reduced wind penetration due to dense development patterns (Vo et al., 2024)—these vernacular strategies remain highly relevant. Data from Nguyen & Tran (2023) indicate that modern high-rise residential buildings in HCMC often rely heavily on air-conditioning because of sealed façades and insufficient natural airflow. Therefore, reinterpreting vernacular ventilation principles provides an evidence-based pathway to reduce cooling loads in high-rise developments.

Similarly, shading and thermal buffering strategies found in traditional architecture, such as deep verandas and multilayered façades, have demonstrated effectiveness in controlling solar radiation and improving indoor comfort (Lim & Tan, 2023). Their high-rise counterparts—recessed balconies, vertical shading fins, double-skin façades, and vegetated screens—can fulfil the same role while enhancing façade performance and energy efficiency. According to Sujono et al. (2023), vegetated shading systems can significantly reduce surface temperatures in tropical climates, further supporting the translation of vernacular logic into vertical architecture.

The use of local materials, another defining feature of vernacular buildings, also contributes to sustainability and carbon reduction goals. Research by Pham & Tan (2025) shows that locally sourced materials and low-carbon alternatives such as engineered bamboo and recycled aggregates can substantially reduce embodied energy in new construction. Integrating these materials into high-rise buildings creates opportunities to merge cultural continuity with Net Zero performance objectives.

Overall, the reinterpretation of vernacular principles—supported by empirical data and contemporary studies—offers a robust and contextually grounded approach for improving the environmental performance of high-rise architecture in Ho Chi Minh City. By anchoring design recommendations in documented research, the hybrid strategies proposed in this study address both the methodological rigor required by academic standards and the practical challenges of designing for tropical megacities.

Fig 4: An Lam Retreats Ninh Vân Bay – A Green Resort Designed and Constructed with Sustainable FSC-Certified Wood Materials. (Source: https://anlam.com/ninh-van-bay/our-retreat, 2025)

Passive Cooling and Natural Ventilation Strategies

Passive cooling and natural ventilation form the backbone of vernacular climatic adaptation in tropical regions. According to Oliver (1997), traditional Vietnamese dwellings are designed with permeable building envelopes, elevated floor plates, and open interior layouts to maximise airflow and reduce indoor heat accumulation. These features allow wind to pass through living spaces efficiently, maintaining thermal comfort even during periods of high humidity. Pham (2024) further confirms that the strategic positioning of openings, combined with the use of transitional spaces such as verandas and semi-open corridors, enhances natural ventilation by creating pressure differentials that facilitate air movement.

In contemporary high-rise buildings in Ho Chi Minh City, however, natural ventilation is often compromised by sealed façades, deep floor plans, and uniform window designs that limit cross-ventilation. Data from Nguyen & Tran (2023) show that more than 70% of recently built high-rise apartments depend primarily on mechanical cooling, contributing significantly to rising energy consumption in the residential sector. These findings underline the importance of revisiting passive ventilation principles in the design of high-rise housing.

To translate vernacular ventilation logic into a vertical architecture context, several strategies can be adapted. Lim & Tan (2023) highlight that features such as breezeways, dual-aspect units, and ventilated lift lobbies significantly improve airflow in tropical multi-storey buildings. Additionally, sky gardens and mid-level voids can serve as air reservoirs that facilitate stack ventilation—a principle observed in traditional houses through roof vents and clerestory openings. These vertical voids create natural pressure differences that support the movement of fresh air upward through the building.

Furthermore, transitional spaces play a critical role in passive cooling when integrated intentionally into high-rise design. According to Nguyen & Le (2023), semi-open communal terraces, shaded corridors, and vegetated balconies help reduce the temperature of adjacent indoor spaces by acting as thermal buffers. Vegetation-based cooling, as demonstrated by Sujono et al. (2023), can decrease façade surface temperatures by up to several degrees Celsius, thereby reducing cooling loads.

These findings indicate that passive cooling and natural ventilation strategies derived from vernacular architecture are not only climatically appropriate but also technically feasible for high-rise applications in Ho Chi Minh City. By grounding these strategies in documented research, this study provides an evidence-based framework for integrating passive systems into modern high-rise housing, supporting both sustainability and Net Zero performance goals.

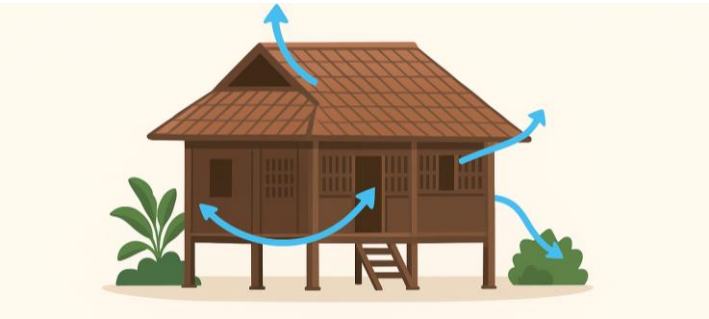

Fig. 5: Natural Ventilation Principles in Vernacular Tropical Houses (Vietnam)
Source: Author, 2025

Applying these methods in multi-storey structures not only reduces mechanical cooling loads but also improves indoor air quality and occupant well-being. By emphasizing passive design strategies, architects can significantly reduce operational carbon emissions without compromising user comfort (Lim et al., 2024).

Local and Low-Carbon Materials for Sustsinable Buildings

The use of local and low-carbon materials is a central component of sustainable design frameworks, as these materials can significantly reduce embodied carbon across a building's life cycle. According to Pham & Tan (2025), the construction sector in Vietnam contributes substantially to national carbon emissions due to the widespread use of energy-intensive materials such as concrete and steel. Transitioning toward regenerative and locally available materials—such as engineered bamboo, reclaimed timber, compressed earth blocks, and regionally produced bricks—offers a practical pathway to lower embodied energy in high-rise housing.

Vernacular Vietnamese architecture has historically relied on local materials not only for availability but also for their climatic suitability. As noted by Oliver (1997), materials such as timber, laterite, and thatch were chosen because they facilitated breathability, moderated indoor humidity, and allowed buildings to respond dynamically to climatic variations. Pham (2024) similarly observes that lightweight, low-thermal-mass materials used in traditional dwellings helped dissipate heat quickly in the tropical climate, reducing the need for mechanical cooling. These insights reinforce the relevance of locally derived materials to contemporary sustainability objectives.

In the context of high-rise construction, modern advancements in material engineering make it possible to reinterpret vernacular material logic within structurally demanding settings. Engineered bamboo, for instance, has been shown to possess compressive strengths comparable to concrete while offering significantly lower embodied carbon (Pham & Tan, 2025). Locally sourced fired bricks and recycled aggregates can also reduce transportation emissions and support the circular economy. According to Nguyen & Le (2023), incorporating locally produced materials into façade and shading systems can improve thermal buffering while reflecting the cultural identity of the region.

Green façades and vegetated shading systems contribute further to sustainable performance by lowering surface temperatures and enhancing insulation. Sujono et al. (2023) demonstrate that vegetated envelopes in tropical buildings can reduce solar heat gain and improve microclimatic conditions, thereby decreasing cooling energy demand. When combined with low-carbon structural materials, these strategies enhance the environmental performance of high-rise developments.

Overall, the integration of local and low-carbon materials—grounded in vernacular construction practices and supported by contemporary engineering research—provides a feasible and culturally resonant pathway for high-rise buildings in Ho Chi Minh City to progress toward Net Zero Carbon objectives. These material strategies not only reduce environmental impact but also reinforce the connection between modern vertical living and the architectural heritage of Vietnam.

Fig. 6: Integration of Local Materials and Passive Facade Design in Contemporary High-Rise Buildings
Source: Author, 2025

Integrating Green Infrastructure and Transitional Spaces

Green infrastructure and transitional spaces form a critical link between vernacular climatic strategies and sustainable high-rise design. According to Oliver (1997), transitional elements in traditional Vietnamese houses—such as verandas, courtyards, front porches, and semi-open galleries—function as microclimatic buffers that moderate heat, promote airflow, and create comfortable living environments without mechanical systems. These spaces also facilitate social interaction and support flexible patterns of daily use shaped by seasonal and climatic changes (Pham, 2024).

In the context of modern high-rise buildings in Ho Chi Minh City, integrating similar spatial logics can significantly improve environmental performance. Research by Nguyen & Tran (2023) shows that current high-rise developments in the city often lack semi-outdoor communal areas, resulting in poor natural ventilation and greater reliance on air-conditioning. Transitional spaces such as shaded terraces, breezeways, sky courts, and open-air corridors can counteract these limitations by functioning as thermal buffers that reduce heat transfer into interior spaces.

Green infrastructure—particularly vegetated façades, balcony planting systems, and rooftop gardens—further strengthens the passive performance of high-rise buildings. According to Sujono et al. (2023), vegetated envelopes can significantly decrease façade surface temperatures in tropical climates, mitigating heat island effects and reducing indoor cooling demand. Similarly, Nguyen & Le (2023) note that greenery integrated into building envelopes improves microclimate quality, enhances shading performance, and contributes to stormwater regulation, reinforcing ecological resilience in dense urban environments.

Sky gardens and mid-level terraces also play a crucial role in enhancing ventilation. Lim & Tan (2023) demonstrate that strategically located voids and sky gardens can serve as "ventilation pockets," facilitating transverse and vertical air movement through the building, especially in urban areas where ground-level winds are obstructed. These design elements mirror the climatic logic of vernacular open courtyards, which rely on pressure differentials to support airflow across interior spaces.

Beyond environmental benefits, transitional and green spaces contribute to social sustainability. According to Oliver (1997), communal semi-open spaces in vernacular settlements foster social cohesion and shared identity. Translating this principle into high-rise environments can enhance residents' well-being, strengthen community ties, and support collective stewardship of shared spaces.

In summary, integrating green infrastructure and transitional spaces in high-rise residential design provides a holistic environmental and socio-cultural strategy for Ho Chi Minh City.

Fig 7: Transitional spaces form sky gardens that allow wind to enter and circulate throughout the building.
Source: https://moitruongxaydungvn.vn/kien-truc-xanh-xu-huong-cua-the-gioi-va-viet-nam, 2025)

Conclusions

This study highlights the enduring relevance of vernacular architectural knowledge for addressing contemporary environmental challenges in high-rise residential design in Ho Chi Minh City. By examining traditional Vietnamese dwellings and comparing their climatic strategies with the limitations of modern high-rise developments, the research demonstrates that vernacular principles offer valuable insights for achieving sustainability and moving toward Net Zero Carbon objectives in tropical megacities.

The findings show that the environmental intelligence embedded in vernacular architecture—particularly its emphasis on natural ventilation, shading, porous envelopes, transitional spaces, and local materials—aligns closely with contemporary sustainability and Net Zero performance frameworks. When reinterpreted for vertical urban environments, these principles provide a foundation for hybrid design models that integrate passive strategies with modern construction technologies and high-rise constraints.

By analysing vernacular environmental strategies and comparing them with contemporary high-rise challenges, the study proposes hybrid design principles that integrate cultural heritage, passive performance, low-carbon materials, and green infrastructure. Indeed, by grounding present interventions in documented vernacular practices and contemporary research evidence, this study demonstrates that such hybrid approaches can strengthen climate resilience, reduce operational energy consumption, and support Net Zero objectives while enhancing the quality of urban living.

Key Conclusions

1. Vernacular environmental strategies provide a climate-responsive design logic that can reduce cooling loads and improve thermal comfort in high-rise buildings.
2. Hybridising vernacular principles with modern technologies enhances resilience and environmental performance in dense urban conditions.
3. Local and low-carbon materials offer effective pathways for reducing embodied carbon while reinforcing cultural identity.
4. Transitional and green infrastructure spaces are essential for improving microclimate quality, enhancing ventilation, and strengthening community well-being.
5. A vernacular-informed approach supports Vietnam's Net Zero goals, offering both environmental and cultural value.

Design and Policy Recommendations

- Architects should integrate passive ventilation, multilayered shading, and vegetated façades as baseline design strategies in high-rise housing.

- Urban planning authorities should incentivise the use of local and low-carbon materials through regulatory frameworks and green building certifications.
- High-rise development guidelines in HCMC should incorporate requirements for transitional spaces and green infrastructure to mitigate heat island effects.
- Educational and professional training programmes should promote vernacular and bioclimatic knowledge as part of sustainable design curricula.

Limitations

This study is primarily qualitative and does not include quantitative simulations such as computational fluid dynamics (CFD) or energy modelling. The analysis focuses on Ho Chi Minh City, and results may require adaptation to other climatic zones or regulatory contexts.

Future Research Directions

Future studies should integrate performance-based evaluations to validate the thermal and energy benefits of the proposed hybrid design strategies. Comparative research across Southeast Asian cities could further clarify how vernacular principles may be adapted for various tropical megacities.

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Conflict of Interest: The author declares that the implementation of this study does not involve any conflict of interest.

Ethical Practice: The author declares that this research has been conducted employing accepted ethical research practices and does not violate the rights of any social group, a person or animals. The data was generated with a full understanding and agreement of the respondents, and owners of the case studies.

Availability of Data: The author declares that the data used in this study are available for verification upon request.

Author Biography

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References

Ahmed, M. (1995) *Dynamic of Urban Change in Residential Areas in an Egyptian City.* Unpublished PhD Thesis. Faculty of Urban Planning, Cairo University.

Ha, N. T. T., Nam, L., Linh, N. S., Duong, V. H. T. & Thanh, L. N. (2022) 'Experiences of some countries in implementing the goal of Net Zero emissions.' *Environment Magazine*, Issue III/2022. Available at: https://tapchimoitruong.vn (Accessed: 01 December 2025).

Kumar, P. & Devi, J. (2024) 'Passive cooling strategies in Indian courtyard houses: Lessons for contemporary design.' *Journal of Sustainable Architecture and Design*, 12(2), 115–129.

Lim, C. & Tan, H. (2023) 'Tropical vernacular architecture: Passive approaches for contemporary design.' *Energy and Buildings*, 293, 113–128.

Lim, C., Nguyen, T. H. & Vo, N. (2024) 'Natural ventilation strategies for tropical high-rise housing: Lessons from Southeast Asia.' *Architectural Science Review*, 67(3), 245–261.
Nguyen, A. & Le, Q. (2023) 'Bioclimatic architecture in Vietnam: Integrating greenery into urban housing.' *ISVS e-journal*, 11(2), 122–136.
Nguyen, H. & Tran, T. (2023) 'Urban high-rise development and energy challenges in Ho Chi Minh City.' *Vietnam Journal of Architecture*, 45(4), 50–58.
Oliver, P. (1997) *Encyclopedia of Vernacular Architecture of the World.* Cambridge: Cambridge University Press.
Pham, T. (2024) 'Traditional Vietnamese houses as climate-responsive models.' *Journal of Architectural Heritage*, 18(1), 60–72.
Pham, T. & Tan, D. (2025) 'Local materials and Net Zero strategies in Vietnam's construction industry.' *Frontiers of Built Environment*, 11(1), 1–14.
Rapoport, A. (1969) *House Form and Culture.* Englewood Cliffs: Prentice Hall.
Sujono, H., Triyadi, S. & Wonorahardjo, S. (2023) 'Passive design and vernacular wisdom in Indonesia's modern architecture.' *ISVS e-journal*, 10(4), 188–201.
Vo, T., Nguyen, D. & Tran, H. (2024) 'Heat Island effects and urban microclimate in Ho Chi Minh City.' *Journal of Environmental Design and Planning*, 29(2), 77–89.

Web / Figure Sources

VertZero (2025) *Vietnamese businesses enter the race to Net Zero by 2050.* Available at: https://vertzero.eco/en/insights/vietnamese-businesses-enter-the-race-to-net-zero-by-2050 (Accessed: 01 December 2025). *(used for Fig. 1)*
Vietnam Airlines (2025) *Traditional Vietnamese house.* Available at: https://www.vietnamairlines.com/hk/en/useful-information/travel-guide/traditional-vietnamese-house (Accessed: 01 December 2025). *(used for Fig. 2 & Fig. 3)*
An Lam Retreats (2025) *Ninh Vân Bay – Our retreat (materials & sustainability).* Available at: https://anlam.com/ninh-van-bay/our-retreat (Accessed: 01 December 2025). *(used for illustrative figure)*
Môi Trường Xây Dựng VN (2025) 'Kiến trúc xanh – xu hướng của thế giới và Việt Nam.' Available at: https://moitruongxaydungvn.vn/kien-truc-xanh-xu-huong-cua-the-gioi-va-viet-nam (Accessed: 01 December 2025). *(used for illustrative figure)*