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ADAPTING TRADITIONAL HOUSES IN INDONESIA TO ENHANCE MODERN BUILDING'S SUSTAINABILITY

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Abstract

Indonesia's growing population and climate change are driving a surge in sustainable housing demand. However, existing construction often falls short of sustainability standards. Meanwhile, traditional houses are recognized for their eco-friendliness and possess significant attributes applicable to modern buildings. Addressing the scarcity of research analyzing Indonesian traditional houses through the lens of green building standards, this study aims to explore the adaptability of East Javanese traditional housing elements to enhance modern building sustainability. Using a qualitative approach, data was gathered through a literature review and in-depth interviews with residents of traditional houses to identify key architectural features. The findings were mapped against the Green Building Council Indonesia's GREENSHIP rating tool. The analysis reveals that traditional elements specifically high ceilings, permeable woven walls, overstek (overhangs), and the use of local materials, align with seven GREENSHIP subcategories. This research confirms that traditional Javanese architecture offers viable, low-energy passive cooling strategies that can be integrated into contemporary designs.

Keywords: Green Building, Passive Cooling, Sustainable Housing, East Java, Vernacular Architecture.

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INTRODUCTION

The construction industry is recognized as a key driver of economic and social development, especially in developing nations. However, it remains one of the largest contributors to global energy consumption and carbon emissions (Zhang et al., 2022). In Indonesia, the sector is expanding rapidly to meet the demands of a growing population. For example, the Program Sejuta Rumah Indonesia (One Million Homes Programme), launched in April 2015, which aim at providing proper housing for low-to-middle-income citizens, the program successfully delivered 1,217,794 housing units in 2023. However, this rapid development often prioritizes speed and cost over sustainability. This approach leads to high levels of CO₂ emissions and an over-reliance on Heating, Ventilation, and Air Conditioning (HVAC) systems, which account for 38% of building energy consumption globally. Furthermore, as a tropical country with year-round sun exposure, Indonesia faces an urgent need for residential construction that minimizes energy consumption from HVAC. As Indonesia commits to reducing greenhouse gas emissions by 29% by 2030 (Humas, 2021), the property sector faces a critical mandate to transition toward green building practices as it is one of the main contributors to global energy use and carbon contributor (Shi et al., 2023).

One emerging solution is the green building concept, which promotes sustainability by reducing energy usage and optimizing resource efficiency throughout a building's lifecycle (Abo El Kasem Ali, 2021). While residential construction continues to grow, many modern Indonesian houses overlook the passive design strategies inherent in the region's vernacular architecture. In contrast to modern developments, which rely heavily on mechanical cooling systems to combat heat and humidity which in turn contributing to higher HVAC and carbon emission, traditional Javanese architecture evolved over centuries to achieve thermal comfort naturally (Handoko, 2020).

Unfortunately, traditional houses are becoming increasingly abandoned in the modern era (Wijaya & Purwanto, 2017). To prevent its extinction, many researchers have documented the philosophy and design of traditional houses. However, existing literature often documents the philosophical or physical aspects in isolation (Prakoso & Wilianto, 2020), only few studies have evaluated these vernacular elements against contemporary green building rating tools to quantify their relevance for modern application. This gap presents a critical opportunity: understanding how traditional design principles align with modern sustainability benchmarks could offer a pathway to reduce carbon emit in Indonesia's residential sector. Therefore, this study aims to explore the adaptability of traditional East Javanese housing elements to enhance the sustainability of modern buildings by seeking to identify the features of

traditional Javanese houses that align with the Green Building Council Indonesia's GREENSHIP rating tool.

LITERATURE REVIEW

Green Building and GREENSHIP Criteria

The green building concept has emerged as a response to the construction industry's environmental impact. It is broadly defined as a practice of creating constructions and employing resource and environmentally-conscious methods for the duration of a building's life cycle (Wong & Zhou, 2015). Another definition of green building is a building that is designed, built, and maintained to minimise the negative environmental effects of building while reducing water and energy consumption as well as its construction costs (Chin Yee Ha et al., 2023). Thus, it is expected to curtail the harm done to the environment through carbon emission, pollution, and waste of its components (Ragheb et al., 2016).

Initial Green building standards mainly emerged from developed countries, for example, BREEAM (Building Research Establishment Environmental Assessment Method) in 1990 in UK; Leadership in Energy and Environmental Design (LEED) in 2000 in US; Green Star in 2003 in Australia; and Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) in 2005 in Japan. In Indonesia, GREENSHIP provides local framework in assessing building performance in 2010 by Green Building Council Indonesia (GBCI) (Mollaoglu et al., 2016). According to GBCI in 2018, to be considered an eco-friendly or green home, a home should be wise in land use, water and energy efficiency, conservation of materials and resources, as well as the health and well-being of its occupants. To help self-assess the buildings, GBCI issued GREENSHIP, a rating tool to benchmark Indonesian green buildings. GREENSHIP has been used for building assessment in order to issue green building certification in Indonesia. Until now, there are 5 types of GREENSHIP, including GREENSHIP for New Buildings, Existing Buildings, Interior Spaces, Homes, and Neighborhoods. For home types, there are six categories, as elaborated in Table 1.

Table 1. GREENSHIP Categories

No.	Categories	Sub-Categories
1.	Appropriate Site Development (ASD)	Providing Green Areas, Encourage development in places that already have supporting infrastructure, Encourage community accessibility, Enforce pest management, Encourage public transportation usage, Stormwater management.
2.	Energy Efficiency and Conservation (ECC)	Electricity sub-metering provision, Artificial lighting incorporation to reduce energy

No.	Categories	Sub-Categories
		consumption, Thermal conditioning to reduce energy consumption, Heat reduction, Energy-saving home appliance implementation, Renewable energy sources utilization.
3.	Water Conservation	Water metering provision, Water-saving fixtures implementation, Rainwater harvesting, Water saving irrigation, Waste Water Management.
4.	Material Resource and Cycle (MRC)	Use of non ODP Refrigerant materials, Material Reuse, Use of environmentally friendly material source, Use of environmentally friendly processed material, Use of certified wood, Use of prefab material, Use of local material, Aware with the carbon footprints.
5.	Indoor Health and Comfort	Fresh air circulation, Use of natural lighting, Visual comfort, Pollutant Source Minimalization, Acoustic Level, Spatial Comfort.
6.	Building Environment Management	Sustainable Design and Construction, Home Guideline, Green Activity, Waste Management, Security, Innovation, Home Design Development.

Source: Green Building Council Indonesia, (2014)

Indonesia Traditional House

A traditional house refers to a residence that reflects the architectural and cultural norms, values, beliefs, lifestyle and technological advancement of the people, community or ethnic groups in a particular region. In Indonesia's history of traditional architecture, the majority of architectural expertise is transmitted verbally from generation to generation (Sardjono & Nugroho, 2015). They represent a vernacular response to the tropical climate, developed through trial and error. Recent scholar argues that vernacular architecture often possesses a higher content of sustainable design than the modern counterparts as they are put forward environmental harmony and resource efficiency (Cheong et al., 2020, as cited in Adib et al., 2025), thus, these houses are often built using locally available materials and construction techniques that have gone through trial and error and passed down through generations. A clear distinction exists between modern and traditional approaches to green living. As noted by Yu et al. (2020) and Abood et al. (2020), modern green houses typically rely on advanced active technologies, for example, the smart home automated systems to control energy consumption, or solar photovoltaic systems, whereas traditional green houses emphasise passive design strategies such as natural ventilation and locally sourced materials.

When discussing traditional houses in East Java, there may be a lot of similarities with the other regions in Java Island because they are from the same tribe, Javanese. Various types of traditional houses in Java can be found in East Java as well, such as Joglo House (Zulkifli & Ika, 2020) Limasan House, “Kampung” House, Houses with Mosque shapes and “Tajug” or “Tarub”, “Panggang Pe” House (Ismunandar, 2003 in Antonius et al., 2014), and the traditional house of the Osing people, an indigenous ethnic group in Banyuwangi city, East Java. (Wijaya & Purwanto, 2017; Suprijanto, 2002).

They exhibit similar ecological architecture principles, which is manifested in the high, pyramid-shaped roof, permeable woven bamboo walls or the use of clay which aligns with the sustainability frameworks in modern ways. Various designs of East Java traditional houses are derived from the philosophical and cultural aspects. These houses often reflect the beliefs and values of the community, such as harmony with nature (Prakoso & Willianto, 2020) and the social status differentiation which is visible from the roof (Wijaya and Purwanto, 2017; Idham, 2018; Prakoso & Willianto, 2020). The lower economy uses the Kampung roof, the medium economy uses the Limasan roof and the richer one uses the Joglo roof (Prakoso & Willianto, 2020; Idham, 2018) which is considered a perfect and sacred house in Java (Dakung, 1968, as cited in Sardjono & Nugroho, 2015; Prabasmara, 2020). In general, this study observes traditional Javanese homes in particular, in which the data are available in previous research studies and from the source persons’ perspective.

This study adopts a conceptual framework (see Figure 1) that links traditional Javanese house elements with contemporary green building assessment criteria. Traditional architectural features are understood as passive environmental design strategies developed in response to the tropical climate. These elements contribute to passive mechanisms including natural ventilation, thermal comfort, heat reduction, and natural lighting. The framework further maps these passive strategies to the Green Building Council Indonesia’s GREENSHIP categories. Through this mapping, the framework shows how vernacular architectural principles can be systematically translated into modern sustainability benchmarks, thereby supporting the adaptation of traditional design knowledge for contemporary housing development.

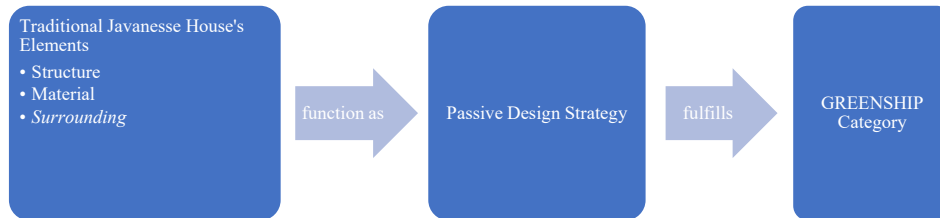


Figure 1. Conceptual Network
 Source: Authors

RESEARCH METHODOLOGY

This study adopts qualitative approach through literature review and in-depth interviews to evaluate the alignment between traditional Javanese architectural design and Indonesia modern sustainability standards. The study follows these stages: Data Collection from literature and interviews; Data Analysis and Comparative analysis against the GREENSHIP Rating Tools as shown in Figure 2.

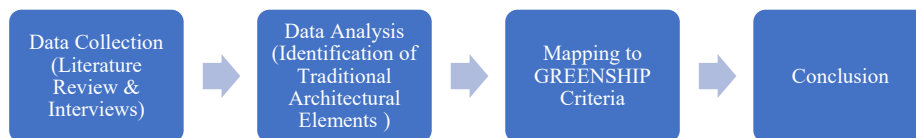


Figure 2. Research Stages
 Source: Authors

1. Data Collection

Traditional Javanese houses have become commonly rare, especially in metropolitan areas. To observe traditional houses, most researchers need to step into the field and make direct observations. Meanwhile, many researchers have documented Traditional Houses Literature in their studies. Thus, due to the place and time limitations, this study mostly gathers and analyzes the data from previously available publications. This research was done through data collection from two primary methods:

- 1) Literature Review. A multifaceted process that entails interpreting a range of published and unpublished documents from different sources on a particular subject. The process ideally involves summarising, analysing, evaluating, and synthesising the documents (Onwuegbuzie et al., 2012, as cited in Antonius et al., 2014). The research data was used from various sources, 16 key articles were selected focusing on published Indonesian and International journals that

explore the topic of traditional Javanese houses and sustainable construction practices.

- 2) In depth interviews. To ensure data triangulation and enhance credibility, the findings will further collaborate through in-depth interviews with two knowledgeable individuals possessing adequate knowledge about traditional Javanese houses. These individuals should have lived in East Java's traditional houses and directly experienced the transition from traditional to modern architectural styles. Two key informants were selected from the Greater Malang area in East Java: Mr. Moch Goeritno (60 years old) and Mr. Soeharwadi (85 years old). Both participants have inhabited traditional houses featuring "sirap" (ironwood) and clay roofs, providing first-hand insights into the passive cooling performance of these structures.

2. Data Analysis and Mapping to GREENSHIP Criteria

Initially, the collected data was identified to find its key architectural features found in the literature. Then we cross reference with the information from the in-depth interviews. To meet the objectives, the result then mapped against GREENSHIP Home (Version 1.0), a rating tool provided by the Green Building Council Indonesia (GBCI). The mapping process identifies specific credits that traditional features can naturally fulfill to understand how they align with green building aspects that can be applied in new housing.

RESULTS AND DISCUSSION

Traditional Javanese House Element and Passive Strategies

The analysis from literature reviews and in-depth interviews with senior residents (Mr. Moch Goeritno and Mr. Soeharwadi) reveals that traditional Javanese houses employ a set of architectural elements that function as passive environmental strategies. The key elements include high ceilings, permeable woven bamboo or wooden walls, large openings and ventilation, overstek (roof overhangs), clay or sirap roofing, extensive vegetation surrounding the house, and the use of local natural materials. These elements are contributing to each physical strategies used in the traditional houses in response of environmental conditions.

Java's climatic conditions are generally beyond the thermal comfort range, particularly during periods of elevated temperature and humidity between August and October (Idham, 2018). Under such conditions, achieving indoor comfort requires architectural responses that reduce solar heat gain while facilitating effective air movement. Traditional Javanese houses demonstrate a long-established climate-responsive design approach, developed through empirical knowledge and cultural practices, which integrates building

orientation, spatial configuration, roof form, material selection, and surrounding landscape to moderate indoor environmental conditions.

Building orientation is one of the fundamental strategies employed in traditional Javanese houses. In tropical climates, east- and west-facing façades receive the highest solar radiation due to the sun's daily movement (Wijaya et al., 2017). Traditional Javanese houses, however, commonly face north or south. While this orientation is closely associated with Javanese cosmological beliefs, such as the symbolic significance of Wisnu's residence in the north and the South Sea ruler (Nyi Roro Kidul) in the south, it also produces a climatic benefit by reducing direct exposure to intense solar radiation. As a result, indoor heat accumulation is indirectly minimised, contributing to a more thermally stable interior environment.

Vertical spatial configuration further enhances passive cooling performance. Traditional house types, particularly Joglo houses, are characterised by high ceilings, which significantly influence air movement within the interior space. High ceilings promote the stack effect, allowing warm air to rise and escape through upper openings, thereby lowering indoor air temperature (Idham, 2018). This mechanism is reinforced by the presence of large doors, wide windows, and dedicated ventilation openings, which ensure continuous airflow throughout the building (Antonius et al., 2014). In addition, the use of permeable bamboo or wooden walls allows air to pass through the building envelope, further enhancing cross-ventilation and indoor comfort.

Roof design constitutes another essential component of the traditional Javanese passive cooling system. Rather than employing flat roof forms, traditional houses utilise pyramid-shaped roofs with wide overstek that provide shading from both solar radiation and heavy rainfall (Maharani et al., 2021). The roof structure typically consists of a wooden frame combined with clay or terracotta roof tiles (Cahyani et al., 2015; Fajarwati et al., 2020). In many cases, the absence of a ceiling leaves the roof structure exposed, allowing warm air to accumulate and exit more effectively. Transparent or perforated roof tiles are sometimes incorporated to permit daylight penetration into interior spaces, reducing the need for artificial lighting. Material permeability, particularly in walls and roofing systems, therefore plays a critical role in facilitating air circulation and thermal regulation (Idham, 2018).

Natural lighting is another defining feature of traditional Javanese houses. Daylight penetration is optimised through the use of large openings, exposed roof structures, and translucent or permeable materials. Woven bamboo panels, commonly used for walls and partitions, not only serve decorative purposes but also allow natural light to penetrate deeper into interior spaces. This approach enhances visual comfort while maintaining airflow. Empirical evidence suggests that woven bamboo contributes positively to thermal comfort, air

quality, and lighting conditions within interior spaces (Ababssi and Prihatmaji, 2024).

The literature findings are strongly supported by in-depth interviews with two senior residents of Greater Malang, East Java, Moch Goeritno (60 years old) and Soeharwadi (85 years old), both of whom have experienced living in traditional and modern houses. They confirmed that thermal comfort in traditional Javanese houses was achieved through a combination of high ceilings, clay or sirap roofs, extensive openings, and abundant vegetation surrounding the house. Both respondents emphasised that trees planted around the house provided natural shading and cooling, while open doors and windows during daytime allowed continuous air circulation. They also noted the presence of perforated roof tiles in some houses, which further enhanced ventilation.

Mapping Traditional Elements to GREENSHIP Criteria

Following the analysis approach, the architectural features identified from the literature and interviews were grouped and systematically mapped against the GREENSHIP for Home (Version 1.0). From the six GREENSHIP categories and 38 subcategories, the analysis indicates that seven subcategories can be naturally fulfilled through the application of traditional Javanese house features, particularly within the categories of Appropriate Site Development (ASD), Energy Efficiency and Conservation (EEC), Material Resources and Cycle (MRC), and Indoor Health and Comfort (IHC).

Energy Efficiency and Conservation (EEC) The primary contribution of traditional architecture lies in its passive cooling capabilities. The Javanese house achieves thermal comfort through structural geometry rather than mechanical systems. Specifically, the high-pitched Joglo roof and the absence of a ceiling board maximize the air volume and facilitate the stack effect, allowing hot air to rise and dissipate. This mechanism directly satisfies EEC 3 (Thermal Conditioning) by eliminating or significantly reducing the need for air conditioning. Furthermore, heat reduction is achieved through the building envelope design. The wide overstek (overhangs) effectively shade the walls from direct solar radiation, while the North-South orientation minimizes exposure on the east-west axis. These strategies collectively fulfill EEC 4 (Heat Reduction) by lowering the overall thermal transfer into the building.

Appropriate Site Development (ASD) Traditional land-use planning offers a blueprint for mitigating the Urban Heat Island effect. Javanese houses are integrally designed with a pekarangan (surrounding garden plot) dedicated to vegetation and tree planting. This zoning practice serves a functional climatic purpose: trees provide microclimate shading and evapotranspiration, which cools the surrounding air before it enters the house. In the context of the rating tool, this

practice directly aligns with ASD 1 (Green Area), addressing the modern challenge of maximizing permeable surfaces in residential developments.

Material Resources and Cycle (MRC) The material palette of the traditional house is inherently sustainable. The construction relies predominantly on locally sourced, renewable resources such as bamboo for walls, timber for frames, and clay or ironwood (sirap) for roofing. These materials possess low embodied energy and are non-toxic. Their usage directly supports MRC 3 (Environmentally Friendly Material Source) by reducing extraction impacts and MRC 7 (Local Material) by minimizing carbon emissions associated with transportation.

Indoor Health and Comfort (IHC) Finally, indoor environmental quality is optimized through envelope permeability. The extensive use of woven bamboo walls and large window openings ensures continuous cross-ventilation, a critical requirement for IHC 1 (Fresh Air Circulation). Unlike airtight modern structures, this breathable skin prevents moisture buildup and stagnation. Simultaneously, the design strategies for IHC 2 (Natural Lighting) are evident in the use of exposed roof frames (allowing for skylight integration) and wide apertures, which balance daylight penetration with glare control.

Table 2. GREENSHIP Categories

No.	GREENSHIP Category	Adaptable Javanese Traditional House Aspect
1.	ASD 1 Green Area	Has plot to gardening or planting trees
2.	EEC 3 Thermal Condition	Not using AC
3.	EEC 4 Heat Reduction	The use of woven bamboo in some of traditional Javanese House The usage of material that can block / prevent heat Overstek Trees to shade the house Large ventilation and opening Open space Direction of the house
4.	MRC 3 Environmental Friendly Material Source	The use of natural sources to be the house material
5.	MRC 7 Local Material	The use of natural sources for housing material, ranging from woods, woven bamboo, local clay, etc.
6.	IHC 1 Fresh Air Circulation	The use of woven bamboo in some of traditional Javanese House - Osing

No.	GREENSHIP Category	Adaptable Javanese Traditional House Aspect
		The use of wide windows and openings.
7.	IHC 2 Natural Lighting	The use of exposed and holed roof The use of woven bamboo in some of traditional Javanese House - Osing The use of wide windows and openings

Comparative Analysis with Tropical Vernacular Context

To contextualise the research findings, this study compares the identified Javanese architectural features with recent scholarship on vernacular architecture across the tropical belt. This comparison illustrates that the alignment between Javanese traditional elements and green building standards reflects a broader set of architectural responses shared by heritage structures in similar climatic zones. The application of roof geometry and shading devices in Javanese houses follows a pattern consistent with other tropical vernacular typologies. Adib et al. (2025) report that traditional Malay houses employ similar elevated floors and open layouts to meet Green Building Index (GBI) requirements. Comparable strategies are documented by Berrak and Kapoor (2021) and Triarma et al. (2025), who observe that wide roof eaves and canopies are common vernacular solutions for reducing solar load. Specifically, Sari et al. (2024) note that expansive overhangs in Gayo Highland mosques serve a primary function in shading, which parallels the role of the Javanese overstek in addressing heat reduction criteria.

The use of permeable building envelopes for ventilation is also observed in broader regional contexts. Petrucci (2023) identifies passive ventilation principles in Indian Havelis and Turkish Ottoman architecture, utilizing windcatchers and porous screens to facilitate airflow. In the Southeast Asian context, Abdul Halim Choo et al. (2024) describe carved wood components in the Rumah Limas Bumbung Perak that function as ventilation panels, operating similarly to Javanese woven bamboo walls in supporting fresh air circulation. Regarding material selection, Ismail (2025) observes that contemporary adaptations of traditional houses in Johor integrate reclaimed wood. This approach aligns with the Javanese practice of utilising durable, local materials such as teak and ironwood, supporting principles of resource conservation and circularity.

The climatic function of the pekarangan (garden plot) corresponds with quantitative studies on microclimates. Michelle and Satwiko (2025) indicate that increasing private green spaces in residential areas can reduce ambient

temperatures by 1 to 2°C. Furthermore, Satwiko and Michelle (2018) found that tree canopies in urban corridors reduced solar radiation on surfaces by approximately 22%. These data suggest that the traditional practice of maintaining vegetated areas around the dwelling contributes effectively to modern Appropriate Site Development objectives.

CONCLUSION

This study establishes that traditional East Javanese architecture serves as a robust prototype for sustainable living, offering time-tested passive design strategies that remain highly relevant to modern environmental challenges. By mapping vernacular elements against the Green Building Council Indonesia's rating tool, this research confirms that traditional houses inherently satisfy seven specific GREENSHIP Homes (Version 1.0) subcategories without relying on complex modern technology.

The synthesis of literature and in-depth interviews reveals three primary architectural contributions to sustainability. First, regarding Energy Efficiency and Conservation (EEC), the structural geometry of the Joglo roof, high ceilings, and North-South orientation effectively facilitate the stack effect and reduce solar heat gain, thereby minimizing reliance on mechanical air conditioning. Second, in terms of Indoor Health and Materiality (IHC & MRC), the use of permeable woven bamboo walls and locally sourced materials (clay, teak, ironwood) ensures continuous cross-ventilation and lowers embodied carbon. Third, regarding Appropriate Site Development (ASD), the traditional pekarangan (garden plot) system serves as a critical ecological buffer, reducing micro-environmental temperatures through vegetation shading.

Implications for Practice The findings necessitate a shift in contemporary housing development practices. For architects and designers, the study suggests moving beyond aesthetic imitation of traditional forms toward a functional integration of passive strategies. For housing developers, adopting the pekarangan ratio concept can significantly mitigate Urban Heat Islands in dense residential clusters. Furthermore, policymakers are encouraged to integrate these vernacular principles into local building codes, incentivizing the use of low-carbon local materials and passive cooling designs as a standard for affordable housing projects.

Limitations and Future Research

While this study provides a comprehensive qualitative assessment based on literature and lived experiences, it relies on perceived thermal comfort rather than empirical data. Future research should focus on quantitative validation through field measurements, utilizing digital thermal sensors and energy simulation

software (such as EDGE or EnergyPlus) to measure the exact temperature differentials and energy savings achieved by these traditional elements.

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REFERENCES

- Ababssi, R., & Prihatmaji, Y. P. (2024, March 31). Enhancing Lighting Efficiency in Kost's Rooms by Utilizing Bamboo Panels. *International Journal of Architecture and Urbanism*, 8(1), 116–124. <https://doi.org/10.32734/ijau.v8i1.14254>
- Abdul Halim Choo, I., Abdul Rashid, M. S., Jamaludin, N. H., Muhammad, A., & Mohd Nor, O. (2024). CLIMATE RESPONSIVE DESIGN IN HERITAGE STRUCTURE: AN ANALYSIS ON THE DECORATIVE ARCHITECTURAL COMPONENTS DESIGN OF RUMAH LIMAS BUMBUNG PERAK (RLBP). *PLANNING MALAYSIA*, 22. <https://doi.org/10.21837/pm.v22i31.1481>
- Abdul Majid, N. H., Denan, Z., Abdul Rahim, Z., Mohd Nawawi, N., & Hazman, S. N. (2017). SUSTAINABILITY CONCEPTS IN MALAY AND ACEH TRADITIONAL HOUSES. *PLANNING MALAYSIA*, 15. <https://doi.org/10.21837/pm.v15i1.216>
- Abo El Kasem Ali, M. (2021, June 1). The role of green buildings in rationalizing energy consumption. *International Journal of Advances Engineering and Civil Research*, 1(1), 21–37. <https://doi.org/10.21608/ijaecr.2023.214442.1011>
- Abood, O. A., Ahad, E. S. A., & Khamis, N. A. A. (2020). The theoretical and practical dimension of sustainability in architecture: Analytical study of a number of architectural projects. *IOP Conference Series: Materials Science and Engineering*, 737(1), 012205. <https://doi.org/10.1088/1757-899X/737/1/012205>
- Adib, A., Mat Nasir, N., Azman, M. A., Makmor, M., & Ahamad, A. H. (2025). ADAPTING MALAY TRADITIONAL HOUSE THROUGH GREEN BUILDING INDEX (GBI) FRAMEWORK: A CASE STUDY OF RUMAH DATO' RAJA DIWANGSA. *PLANNING MALAYSIA*, 23. <https://doi.org/10.21837/pm.v23i38.1877>
- Berrak, Y., & Kapoor, S. (2021). Understanding Energy Efficient Techniques in Traditional Architecture. *2021 International Conference on Electrical, Computer and Energy Technologies (ICECET)*, 1–6. <https://doi.org/10.1109/ICECET52533.2021.9698461>
- Ahmed Ali, K., Ahmad, M. I., & Yusup, Y. (2019). Issues, Impacts, and Mitigations of Carbon Dioxide Emissions in the Building Sector. *Sustainability*, 12(18), 7427. <https://doi.org/10.3390/su12187427>
- Antonius, A., Achmad, D., Suryabrata, I., & Adi, D. (2014, July 1). The Concept of Modern Dutch Colonial Architecture to the Development of Javanese Architecture. *Dimensi, Journal of Architecture and Built Environment*, 41(1). <https://doi.org/10.9744/dimensi.41.1.37-42>

- Chin Yee Ha, Terh Jing Khoo, & Zheng Yik Koo. (2023, August 10). Current status of green building development in Malaysia. *Progress in Energy and Environment*, 25(1), 1–9. <https://doi.org/10.37934/progee.25.1.19>
- Cahyani, R., Wulandari, L. D., & Antariksa, A. (2015). Pengaruh arsitektur tradisional Jawa dalam hunian kolonial di kampung Bubutan Surabaya. *RUAS*, 13(1), 56-65.
- Fajarwati, A. N., Efendi, M., Suhariyanto, S., & Sudarmanto, S. (2020). Identifikasi Struktur Bangunan Rumah Tradisional di Desa Pinggirpapas. *NALARs*, 19(2), 139. <https://doi.org/10.24853/nalars.19.2.139-148>
- Green Building Council Indonesia. (2018). *Rating Tools*. Retrieved November 22, 2018, from <http://gbcindonesia.org/>.
- González-Torres, M., Pérez-Lombard, L., Coronel, J. F., Maestre, I. R., & Yan, D. (2022). A review on buildings energy information: Trends, end-uses, fuels and drivers. *Energy Reports*, 8, 626-637.
- Handoko, J. P. S. (2020). Comparative Study on Application of Ecological Architecture Concept on Javanese Traditional House in Central Jawa. *Proceedings of the EduARCHsia & Senvar 2019 International Conference (EduARCHsia 2019)*. <https://doi.org/10.2991/aer.k.200214.025>
- Humas (2021, February 8). President Jokowi: Indonesia Committed to Reducing Emission by 29%. Sekretariat Kabinet Republik Indonesia. <https://setkab.go.id/en/president-jokowi-indonesia-commits-reducing-emission-by-29/>
- Idham, N. C. (2018, September). Javanese vernacular architecture and environmental synchronization based on the regional diversity of Joglo and Limasan. *Frontiers of Architectural Research*, 7(3), 317–333. <https://doi.org/10.1016/j.foar.2018.06.006>
- Ismail, A. S. (2025). Integration of Kejawen Moralistic Values in Javanese Traditional Houses Towards Communal Living in Malaysia. *International Journal of Culture and Art Studies*, 9(1), 39–63. <https://doi.org/10.32734/ijcas.v9i1.18675>
- Maharani, S. A., Suartika, G. A. M., & Saputra, K. A. (2021). Transformasi Elemen Rancang Bangunan Tradisional dalam Tampilan Arsitektur Bangunan Kekinian. *SPACE*, 8(1).
- Michelle, B., & Satwiko, P. (2025). Striking a Balance Between Nature and Development: Investigating Private Green Spaces using ENVI-met. *Journal of Regional and City Planning*, 35(3), 305–321. <https://doi.org/10.5614/jpwk.2024.35.3.4>
- Mollaoglu, S., Chergia, C., Ergen, E., & Syal, M. (2016). Diffusion of green building guidelines as innovation in developing countries. *Construction innovation*, 16(1), 11-29.
- Petrucchi, C. (2023). *Thermal Comfort in Traditional and sustainable buildings*.
- Prabasmara, P. G., Wibowo, S. H., & Yuniastuti, T. (2020). Kajian Struktur Bangunan Tradisional Jawa pada Bangsal Kencana Keraton Yogyakarta. *Sinektika: Jurnal Arsitektur*, 16(1), 44-51.
- Prakoso, B. P., & Wilianto, H. (2020, August 1). Penerapan konsep kejawen pada rumah tradisional Jawa. *ARTEKS: Jurnal Teknik Arsitektur*, 5(2). <https://doi.org/10.30822/arteks.v5i2.219>

- Ragheb, A., El-Shimy, H., & Ragheb, G. (2016). Green Architecture: A Concept of Sustainability. *Procedia: Social & Behavioral Sciences*, 216, 778–787. <https://doi.org/10.1016/j.sbspro.2015.12.075>
- Sardjono, A. B., & Nugroho, S. (2015). Keragaman Perubahan pada Rumah Tradisional jawa di pedesaan. *Modul*, 15(2), 141-156.
- Sari, L. H., Wulandari, E., & Idris, Y. (2024). An investigation of the sustainability of old traditional mosque architecture: Case study of three mosques in Gayo Highland, Aceh, Indonesia. *Journal of Asian Architecture and Building Engineering*, 23(2), 528–541. <https://doi.org/10.1080/13467581.2023.2245006>
- Satwiko, P., & Michelle, W. (2018). REDUCING SURFACE TEMPERATURES OF NORTH-SOUTH BUSINESS CORRIDORS IN YOGYAKARTA. *DIMENSI, Jurnal Teknik Arsitektur*, 42(2), 59–68.
- Suprijanto, I. (2002). Rumah Tradisional Osing Konsep Ruang dan Bentuk. *Dimensi (Journal of Architecture and Built Environment)*, 30(1).
- Shi, Q., Liang, Q., Wang, J., Huo, T., Gao, J., You, K., & Cai, W. (2023, January). Dynamic scenario simulations of phased carbon peaking in China’s building sector through 2030–2050. *Sustainable Production and Consumption*, 35, 724–734. <https://doi.org/10.1016/j.spc.2022.12.003>
- Triarma, P. I., Setiyo Cahyono, H., & Carina, A. (2025). CONCEPT OF MODERN RESIDENTIAL HOUSES OF BALI ARCHITECTURE IN SUPPORTING ENVIRONMENTAL SUSTAINABILITY. *DEARSIP: Journal of Architecture and Civil*, 5(02), 235–256. <https://doi.org/10.52166/dearsip.v5i02.11073>
- Wijaya, P. Y., & Purwanto, S. A. (2017). Studi Rumah Adat Suku Osing Banyuwangi Jawa Timur. *Buku Prosiding Simposium Nasional*.
- Wong, J. K. W., & Zhou, J. (2015). Enhancing environmental sustainability over building life cycles through green BIM: A review. *Automation in Construction*, 57, 156–165. <https://doi.org/10.1016/j.autcon.2015.06.003>
- Yu, L., Xie, W., Xie, D., Zou, Y., Zhang, D., Sun, Z., Zhang, L., Zhang, Y., & Jiang, T. (2020). Deep reinforcement learning for smart home energy management. *IEEE Internet of Things Journal*, 7(4), 2751–2762. <https://doi.org/10.1109/JIOT.2019.2957289>
- Zhang, S., Ma, M., Xiang, X., Cai, W., Feng, W., & Ma, Z. (2022, October). Potential to decarbonize the commercial building operation of the top two emitters by 2060. *Resources, Conservation and Recycling*, 185, 106481. <https://doi.org/10.1016/j.resconrec.2022.106481>.
- Zulkifli, A., & Ika, R. (2020). Eksplorasi Rumah Adat Joglo Pada Materi Geometri di Sekolah Dasar. *Jpgsd*, 8(3), 591-600.

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