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Sustainable Architecture Practice in Indonesia: Navigating Global Standards and Local Knowledge

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ABSTRACT

This study investigates how Indonesian architects navigate between global green building rating tools (GBRTs) and context-specific design strategies across different project types and scales. Using a comparative analysis of sixteen award-winning projects by six Indonesian architects, the research combines semi-structured interviews with document review and inductive coding to map design logics against core GBRT categories. The analysis is organized around six themes used by GBRTs—energy efficiency, material resources and cycles, water conservation, sustainable site development, indoor health and comfort, and building resilience and adaptability—and identifies two additional themes central to Indonesian practice yet largely absent from GBRT assessment—social collaboration in the design process and cultural values. Findings reveal that in small- to medium-scale private and CSR projects, architects exercise greater autonomy to implement low-tech, community-based strategies, including passive cooling, proximate and recycled materials, hydrological restoration, and collaborative building processes. By contrast, large, regulation-led government projects tend to limit sustainability to compliance requirements, resource accounting, and site-level mitigation, often marginalizing socio-cultural dimensions and constraining contextual innovation. Across all design themes, recurring misalignments appear between GBRTs' measurable proxies and architects' context-driven values. These frictions show that what counts as sustainability in GBRTs—simulation outputs, certifications, and prescriptive thresholds—does not consistently capture what sustains practice on the ground: community resilience, ecological balance, and cultural continuity. In Indonesia, a context-aligned recalibration that recognizes adaptive comfort, vernacular material cycles, and participatory processes can keep GBRTs rigorous while making them more responsive to climatic logics, cultural values, and long-term stewardship norms.

Keywords: green building rating tools (GBRTs), Indonesian architecture, community-based design, low-tech sustainable strategies, context-responsive design

INTRODUCTION

Green Building Rating Tools and the Sustainability Paradox

Across the built environment, the global sustainability agenda and climate change mitigation have increased demand for tools that consistently measure and improve environmental performance. Green building rating tools (GBRTs), such as BREEAM and LEED serve as accountability infrastructure that enables governments, professionals, and investors to document, verify, and communicate carbon reduction and broader sustainability outcomes. (Awadh, 2017; Isaksson et al., 2022; Varma & Palaniappan, 2019). Since BREEAM (1990) and LEED (1998) established widely adopted templates, many countries have localized comparable frameworks (Building Research Establishment, 2021; USGBC, 2025). Indonesia adapted LEED's core principles into GREENSHIP (2009), a GBCI-led, context-specific framework substantially modified for the country's tropical climate, urban infrastructure, material availability, and regulatory conditions (Greenship, 2024). This practitioner- and developer-driven tool helped institutionalize early green-building practice. The government later formalized requirements through the Green Building Performance Assessment (PKBGH) in 2015, updated in 2021 (Kementerian PUPR, 2021), making certain provisions mandatory for public and large projects while remaining largely voluntary for private ones. Whereas GREENSHIP functions as a voluntary certification pursued mainly for environmental credentials, PKBGH establishes the legal compliance basis, especially for public-sector projects.

GBRTs strongly prioritise energy efficiency, technological innovation and industrial-scale solutions; however, the overly complex credit structure and rigid weighting system severely compromise their practical applicability and reduce their relevance in various real-world contexts (Saleh et al., 2024; Varma & Palaniappan, 2019; Vyas & Jha, 2016). The developers of these rating tools adopt a predominantly technocratic approach, reflecting the logic and conditions of industrialized countries, such as the UK and the US, which have advanced technological capabilities, widespread access to material innovation and clean energy, and established development infrastructure. This technocratic orientation limits the adaptability of rating tools in developing countries and deepens the broader sustainability paradox. While these tools set high benchmarks tailored to the context of developed countries, they often ignore structural disparities between countries at different stages of development. The paradox stems from the global sustainability agenda and climate-change mitigation frameworks that often expect both developed and developing nations to meet uniform sustainability performance benchmarks, despite vastly different historical contributions to emissions and unequal capacities to address them (Hartley, 2020; Park, 2024; Reid & Rout, 2020; Wirjawan, 2024). Within the global sustainability agenda and climate-change mitigation frameworks, developing countries are expected to deliver comparable sustainability performance despite unequal historical emissions and capacities. Given that high-income countries grew through intensive fossil-fuel use, applying the same globally designed rating requirements to all contexts is increasingly unfair. The technocratic criteria embedded in this toolkit—assuming advanced infrastructure, mature green technology markets, and high purchasing power—do not match the reality in developing countries, where reliance on local resources, affordable fossil fuels, and more basic stages of development are still crucial (Wirjawan, 2024; Zhukovskiy et al., 2021).

Previous research shows that energy efficiency standards and compliance pathways in GBRTs reinforce the logic of closed buildings that rely on HVAC systems in temperate climates, so that the application of these standards in tropical contexts is often unbalanced (Khan et al., 2019). In practice, this mismatch is evident at the level of specific requirements. For example, LEED EA Minimum Energy Performance (ASHRAE 90.1) and BREEAM Ene 01 provide incentives for savings modelled on a baseline focused on HVAC, which underestimates free operation modes and passive cooling. Expectations regarding building materials are also often misaligned: High-performance products and supply chain certifications prioritized by GBRTs can be expensive or unavailable, making low-carbon local alternatives administratively invisible

(Illankoon et al., 2019). Beyond technical suitability, acceptance and adoption are influenced by metric literacy and governance: Local stakeholders often struggle to understand global metrics (Lam et al., 2024), contractors face tight budget constraints (Zainul Abidin & Powmya, 2025), and without regulatory support and local addenda, GBRTs remain normative and distant from practice (Razman et al., 2023). Collectively, these frictions reveal a core evidence gap: What works locally is not always measurable in GBRT verification.

Recognising these disparities highlights the importance of recognising the distinctive capacities possessed by developing countries that contribute to sustainability efforts. These capacities include the adaptive use of local materials and adopting local architectural strategies that are proven to be energy-efficient and honed by local resources, geography, and climate (Hanan & Wonorahardjo, 2012; Memmott et al., 2023; Pareti et al., 2022; Rashid & Ara, 2015; Salman, 2019; Sirror, 2024). Such strategies are climate-responsive and often embedded in culturally specific social practices and communal ways of life that promote sustainability more than technical performance (Memmott & Keys, 2015; Nielsen, 2022; Olukoya & Atanda, 2020; Wu et al., 2016). However, global sustainability rating tools often fail to fully reflect these potentials, as they favor scalable high-tech solutions over culturally embedded low-carbon practices. This technocratic bias tends to marginalize regionally appropriate solutions and reduce sustainability to a checklist of universal metrics, ignoring the layered socio-material wisdom embedded in local knowledge (Diaz-Sarachaga et al., 2017; Griffiths et al., 2018; Yakoub et al., 2021).

Architectural Practice, Sustainability, and the Indonesian Context

The architectural profession holds a dual and paradoxical position in the climate crisis. On one hand, architects significantly contribute to global carbon emissions, with the building and construction sector responsible for nearly 37% of global energy-related CO_2 emissions, highlighting the profession's pivotal role in shaping environmental outcomes (UN Environment Programme, 2022). On the other hand, design decisions made in the early stages of a project can determine up to 80% of its lifetime costs and carbon footprint (Robati et al., 2021). This paradox underscores the urgent need for change, but also the unique power of architecture to drive transformative change, inspiring architects to use their profession for the betterment of the environment.

In Indonesian architectural practice, previous research has examined how architects negotiate global discourses and local contextual specificities through three interrelated strands. First, studies on the construction of local architectural identity show that vernacular traditions are dynamic processes mediated by politics, history, and culture; architecture functions not merely as a physical building but also as a cultural–political instrument (Kusno, 2010a, 2010b; Purwaningrum, 2019, 2021). Second, research on rationality and creativity in the design process of Indonesian architects highlights how cognitive frameworks translate pragmatic constraints into innovative solutions, clarifying how architects operationalize design logics (Widiarso, 2022; Widiarso et al., 2021). Third, scholarship on sustainable architecture emphasizes climate-responsive and low-tech strategies—such as passive ventilation and shading, material reuse, and craft-based detailing—rooted in vernacular knowledge and local material cycles (Andracana, 2023; Nabilunnuha et al., 2022; Paramita et al., 2022; Wasilah, 2023; Widodo, 2019). Yet a significant research gap remains: There is no systematic study of how Indonesian architects navigate sustainability themes embedded in green building rating tools (GBRTs)—such as LEED, BREEAM, GREENSHIP, and related standards—in relation to context-specific local strategies oriented toward tropical ecologies, cultural continuity, and resource circularity. While prior scholarship has established cultural and climatic foundations for sustainability, it seldom maps how these strategies are operationalized by architects, nor does it examine the extent to which evidence pathways within certification regimes facilitate or undermine the effectiveness of local knowledge

This study reframes architecture not merely as a site of problems but as a strategic domain for implementing sustainable design interventions. In

Indonesia, architectural practice does not only take place within the framework of GBRT assessment; architects utilize local knowledge to produce outcomes that have a lower impact and are integrated into the culture, which is not always recognized by formal credit structures. This study therefore analyzes how Indonesian architects navigate between global standards and local strategies across different types and scales of projects, and identifies the most frequently applied design strategies to promote climate mitigation and resource efficiency goals while maintaining cultural continuity and ecological integrity. By identifying where GBRT evidence pathways facilitate or undermine the effectiveness of local knowledge in tropical regions, as well as how architects negotiate these boundaries, this study provides an applicable bridge from global frameworks to practices and policies rooted in local contexts.

METHODOLOGY

Research Strategy and Unit of Analysis

The comparative method is employed in this research to analyze Indonesian architects' design strategies in award-winning works aimed at achieving architectural sustainability. What sets this research apart is its focus on how Indonesian architects employ contextualized and locally based sustainability strategies, which differ from the technocratic approaches commonly found in GBRTs. This unique approach is evident in the case study, which examines architectural works and practices that have garnered national or international recognition over the past decade. Within the framework of Cross's design research, this analysis emphasizes design epistemology, which explores how architects think about and articulate challenges related to sustainability and local context, as well as design phenomenology, which examines how these processes manifest in the physical form of architecture (Cross, 2023; Lee et al., 2020).

Data Selection and Collection

To ensure their relevance to the research focus, architect participants were selected based on the following criteria: (1) senior architects with a minimum of 15 years of professional experience, (2) architects who respond to local values and contexts in their work to promote sustainable architecture, and (3) recipients of national or international architecture awards within the last ten years (2015-2025). The last criterion is important because it identifies architects who are recognized by the professional architecture community, with creative contributions acknowledged through evaluations from experts in the field (Makwaney, 2021; Peltason & Ong-Yan, 2017; Riaubiene et al., 2023; Styhre & Brorström, 2023; Widiarso et al., 2021). Since not all awards publish their complete assessment criteria, we determined the extent to which sustainability was prioritized by looking at: (i) the published award assessment criteria (if available), (ii) quotes from the jury, and (iii) the board of works used for the award. From these sources, we found that these works not only consider environmental impact but also consider social impact and suitability to the local context. We retained these cases given their relevance to this research and its exploration of how architects combine assessment measures with local knowledge and how this combination is recognized or ignored by formal credit structures. Details of the architects' works, award-winning projects, types of awards, and sources used to determine the assessment criteria can be seen in Table 1.

This study focuses on 16 nationally and internationally awarded projects designed by 6 Indonesian architects known for their sustainable and context-responsive approaches. Although the number of participants is limited, the researchers justify the selection within a qualitative framework that prioritizes depth, contextual relevance, and diversity of architectural practice over sample size (Junaidy & Nagai, 2017; Marshall et al., 2013; Widiarso et al., 2021). Figure 1 shows the distribution of 16 award-winning projects spread across the Indonesian archipelago. Most of these projects are concentrated in major cities in Java, such as Tangerang, Bandung, and Sidoarjo. Meanwhile,

Table 1

Inventory of Awarded Projects

Level	Year	Architect code	Awarded projects in the last 10 years	Award	Source of project evaluation criteria
International	2014	AR-1	Pahoa Kindergarten	Best Asia Pacific Property Awards – (Public Service Development) World Gold Winner FIABCI (Purpose Built Category) World Silver Winner FIABCI – (Sustainable Development Category)	award criteria
	2016	AR-3	Rumah Belajar Lingkungan Ocean of Life Indonesia	Green Leadership Award BCI Asia	award criteria
	2015		WIKA Leadership Centre/Wikasatrian	Citation of Excellent Architectural Design Reflecting East Asian Identity	award criteria
National	2021	AR-6	Dusun Bambu	IAI Awards	jury citation
	2024	AR-1	Golo Mori Convention Center	IAI Awards	award design board
		AR-2	STT Makedonia	IAI Awards	award design board
Regional	2018	AR-5	Obsolete House/Omah Amoh	IAI Jatim Awards	award design board
	2021	AR-6	Warung Pengepul Kayu	IAI Jabar Awards	award criteria
			Eagle School	IAI Jabar Awards	award criteria
			LMBG Officafe	IAI Jabar Awards	award criteria
			Forest Walk Babakan Siliwangi	IAI Jabar Awards	award criteria
		AR-4	Omah Boto	IAI Jatim Awards	jury citation
	2022	AR-3	Rumah Kayu Ciledug	IAI Jabar Awards	award criteria
			Mess Buruh Cengklong	IAI Jabar Awards	award criteria
	2024	AR-4	Lego Mosque/Masjid Al-Fattah	IAI Jatim Awards	award design board
		AR-2	Riau 20	IAI Jabar Awards	award criteria

projects outside Java, including Ngabang (Kalimantan) and locations in Nusa Tenggara, illustrate diverse cases in rural or remote areas, which are located further away from metropolitan centers and influenced by unique geographical and local conditions.

This study employed semi-structured, open-ended interviews with expert architects to elicit how design strategies are formed in practice (Daly et al., 2012; Lee et al., 2020; Purwaningrum, 2021; Tienthavorn, 2024; Widiarso, 2022). The interviews used open-ended questions, allowing participants to lead the conversation and articulate their arguments, intentions, and contextual considerations in depth (Bryman, 2016; Chapman et al., 2015; Gramkow et al., 2022; Stierand & Dörfler, 2016). All sessions were video/audio-recorded and transcribed for analysis. Secondary data were obtained from document reviews of architectural publications, award boards, and project materials available on official websites and social media. Given the public nature of architectural works, participants were anonymized while their publicly available projects were referenced. Codes (e.g., AR-1, AR-2) were assigned to architects, thereby protecting identities without impeding critical analysis of design strategies (Ahuja & Weatherall, 2023; Shaw, 2008; Uzunkaya & Paker Kahvecioğlu, 2022; Widiarso et al., 2021; Wiles et al., 2008).

Figure 1

Geographic Distribution of Case Projects

Note. Base map adapted from *Google Maps*, by Google, n.d., Google Maps (https://www.google.com/maps). Copyright n.d. by Google LLC. Project images are compiled from official project websites and awarding board publications and edited and assembled by the author using Microsoft PowerPoint. Copyright of individual images remains with their respective copyright holders.

Comparative and Analytical Framework for Sustainable Architecture Projects

Awarded projects were compared with respect to (1) building typology, (2) client type, and (3) design strategy, with information derived from the interview/document coding and read against core GBRT criteria in LEED, BREEAM, Greenship, Edge, and PKBGH. A subset of GBRT-derived design criteria was analytically selected based on their frequency of occurrence across these rating tools and their contextual relevance to architectural practice in Indonesia . The frequency of criteria themes in GBRTs can be seen in Table 2**.** We also compare projects along the other two axes (building typology and client type) because architects work with diverse stakeholders (government, private sector, NGOs, and communities), each with distinct priorities (Peters, 2015; Wang, 2020).

Central themes were selected for their strong relevance to the practice of sustainable architecture globally and contextually in Indonesia. There are: (1) Energy Efficiency, (2) Material Resources and Cycle, (3) Water Conservation, (4) Sustainable Site Development, (5) Indoor Health and Comfort, (6) Accessibility and Connectivit,y and (7) Building Resiliency & Adaptability. These issues are fundamental to achieving sustainable architecture. In addition, although the Building Resiliency & Adaptability theme does not appear much in the global rating tools, it was still added due to its high local relevance to Indonesia's status as a disaster-prone country.

The core themes were then operationalized via a qualitative coding protocol grounded in architects' lived design experience. The conceptual framework was developed through open and axial coding, enabling a close reading of narratives on how practitioners interpret, navigate, and respond to sustainability in locally grounded practice (Li & Qu, 2022; Liu & Kang, 2016). In the open coding stage, interview transcripts and secondary documents were broken down into units of meaning. Axial coding then grouped these units into initial themes and traced their interrelations, whether aligned with GBRT assessment criteria or reflecting locally relevant sustainability concerns beyond established frameworks. The resulting design strategy themes were mapped across project types and substantiated with verbatim excerpts from architects to reinforce the argument.

RESULTS

Adaptive Strategies Aligned with Rating-Tool Themes

Open and axial coding of interviews and documents shows that Indonesian architects respond proactively to sustainability issues by addressing core GBRT themes while adapting measures to local resources and constraints. In all cases, performance is achieved primarily through nature-based solutions (NBS), site-responsive approaches that maintain ecosystems, and passive design strategies. These approaches are often grounded in local practices related to airflow, thermal and visual comfort, and the use of locally available resources (materials, water, and energy). These choices reflect a low-tech approach that relies on nature-based solutions and local resources, with a focus on evidence-based implementation to achieve performance: Architects meet GBRTs theme objectives through tactics tailored to the local context, reducing dependence on systems that require large capital investments and intensive maintenance. Table 3 details these strategies.

Local-Contextual Sustainability as a Social and Cultural Process

The analysis also shows that local-contextual sustainability is understood and practiced as a social and cultural process, not merely a technical outcome. Architects collaborate in designing with local actors—craftsmen, contractors, students, and communities—enabling two-way learning that strengthens skills, preserves craft knowledge, and distributes responsibility for building management and maintenance for the future. This social and cultural integration is evident in both community facilities and individual residences. It strengthens emotional ties to place, supports capacity building, and often motivates ongoing care for the landscape and buildings. Practices in Indonesia promote sustainability not only through themes that align with GBRTs, but also go beyond that, by institutionalizing collaboration and socio-cultural continuity that are currently not recognized by existing GBRT assessments. Table 4 details these strategies.

Table 2

Frequency of Criteria Themes in GBRTs

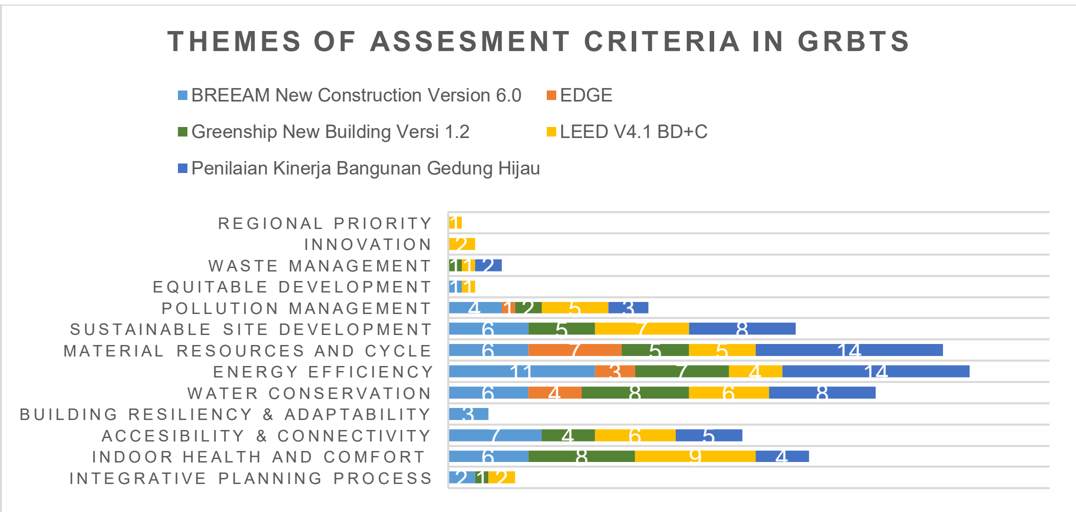


Table 3

Thematic Design Strategies for Sustainability Aligned with GBRTs

Thematic design strategy for sustainability (GBRTs aligned)						
Accessibility and connectivity	**Building resiliency and adaptability**	**Energy efficiency**	**Indoor health and comfort**	**Material resources and cycle**	**Sustainable site development**	**Water conservation**
Accessibility for persons with disabilities	Spatial adaptability	Renewable energy	Thermal comfort for occupants	Construction cost efficiency	Green spaces	Greywater recycling
	Building adaptive reuse	Locally based architectural strategies for passive design	Locally based strategies for visual comfort	Material efficiency	Productive land management	Rainwater harvesting
	Building resilience to hazards/disasters	Passive design strategies	Views to nature	Innovations in timber connections/ joinery	Nature-based water management	Reduction of groundwater use
	Construction that avoids altering existing conditions			Unfired brick	Preserving existing ecosystems	
				Salvaged building materials	Reducing building impact on site	
				Waste-derived materials	Development on degraded/ "negative-value" land	
				Reuse of existing/on-site materials	Natural ecosystems for local self-sufficiency	
				Industrial materials	Organic land management	
				Local materials		
				Modular materials		
				Local material producers		
				Self-managed/on-site material production		

Table 4

Thematic Design Strategy for Sustainability, Local-Contextual Themes

Thematic design strategy for sustainability (Local-contextual themes)			
Cultural values	**Human-centered design**	**Social collaboration in the design process**	**Socio-economic and community values**
Architectural identity and symbolism	User safety and comfort considerations	Co-design with artisans, builders/contractors	Exploration of local community cultural values
Brick patterning inspired by traditional decorative elements		Co-design with artisans, builders/contractors	
Inspiration/ translation from traditional/ vernacular architecture		Training for local artisans	
Cultural narratives		Artisan knowledge and skills	
Canonical elements of traditional architecture			
Communal spaces			

Differentiation of Sustainability Strategies based on Project Typology and Client Types

Design strategies that are aligned with GBRTs or rooted in the local social and cultural context produce alternative sustainability strategies, the manifestations of which vary in different institutional environments. These differences will be explained based on project client type: government, private sector, CSR-NGO, or individual.

Government Projects

Government-funded projects, including those carried out by state-owned enterprises such as the Golo Mori Convention Center and the Wikasatrian Leadership Center (WIKA), as well as local government initiatives such as the Babakan Siliwangi Forest Walk, generally adopt a technocratic approach to sustainability. Established institutional regulations and functional requirements often limit architects' ability to fully implement comprehensive sustainability strategies. The detailed strategies and their interrelations within sustainability themes in government projects are presented in Table 5.

The most commonly observed architectural strategy in government projects is a site-responsive approach, which encompasses eight different strategies. In local-government projects such as the Babakan Siliwangi Forest Walk, sustainability is framed through a calculus of minimal ground impact and regulatory compliance. As the architect notes,

> “If we calculate the building coverage ratio (KDB), it actually only comes down to the foundation points. They are just 30x30 centimeters, multiplied by the number of points...and that is all there is,” and therefore, “in Babakan Siliwangi people can walk through the area without damaging the plants or the soil, because the pathway had to be designed as an elevated structure”
>
> (AR-6, personal communication, March 13, 2025).

Table 5

Thematic Design Strategy in Government Projects

Thematic design strategy for sustainability (GBRT aligned)	Architect	Awarded Project	Design Strategy
Accessibility and connectivity (1 strategy)			
Accessibility for persons with disabilities	AR-6	Forest Walk Babakan Siliwangi	Accessibility for people with disabilities
Building resiliency and adaptability (1 strategy)			
Building adaptive reuse	AR-6	Forest Walk Babakan Siliwangi	Introducing new program into an existing building
Indoor health and comfort (1 strategy)			
View of nature	AR-1	Golo Mori Convention Center	Orientation to sea views
Sustainable site development (8 strategies)			
Development on degraded/“negative-value” land	AR-6	Forest Walk Babakan Siliwangi	Abandoned/brownfield site
Reducing building impact on site			Minimizing built-up area
Nature-based water management	AR-1	Golo Mori Convention Center	Nature-based water management
			Natural water-catchment areas
Preserving existing ecosystems			Ecosystem conservation
Reducing building impact on site			Elevated structure
Green spaces			Preserving on-site vegetation
	AR-3	WIKA Leadership Centre/Wikasatrian	Terraced landform (terracing)
Water conservation (1 strategy)			
Reduction of groundwater use	AR-1	Golo Mori Convention Center	Reduced groundwater extraction
Thematic design strategy for sustainability (Local-contextual themes)	**Architect**	**Awarded Project**	**Design Strategy**
Cultural values (3 strategies)			
Architectural identity and symbolism	AR-3	WIKA Leadership Centre (Wikasatrian)	Mountain-like massing symbolising the Ring of Fire
			Maritime-nation symbolism
			Semar silhouette expressed in the plan

Meanwhile, the state-owned Golo Mori Convention Center articulates site-responsiveness primarily through hydrological ethics. The architect recalls,

> “The very first concern there was the issue of water...The initial idea was water conservation…whether we had to alter the natural hydrology or not. My choice was to place a fairly large building while still ensuring that the entire natural water management system remained intact,” adding that, “The one thing we cannot compromise here is the environmental issue...We must be very careful with water management. Can we avoid extracting groundwater?”
>
> (AR-1, personal communication, November 16, 2024).

Across these two cases, elevated or piled structural systems, allow architecture to float above the ground, thereby preserving the natural topography, reducing soil compression, and maintaining existing vegetation networks, as shown in Figure 2.

In contrast, the integration of cultural values into these designs remains limited. Cultural considerations tend to manifest in the form of architectural ornamentation, façade articulation, or naming conventions rather than in the social or performative dimensions of space that facilitate everyday cultural practices. This selective incorporation reflects the rigid design protocols commonly found in public sector architecture, where buildings function more as representations of institutional or national identity than as platforms for dynamic cultural expression. For the example, with the WIKA Leadership Center, cultural identity is mobilized chiefly through symbolic form under an institutional brief, as the architect explains, “The Terms of Reference (TOR) had to represent Indonesia. It had to be iconic...In the end, I identified one defining characteristic—that Indonesia lies in the ‘Ring of Fire’...That is why the building form was conceived as a mountain” (AR-3, personal communication, October 15, 2024).

Private Sector Projects

Private sector projects such as Pahoa Kindergarten, Dusun Bambu (ecotourism), Lego Mosque, and Riau 20 (a commercial program in a heritage building), demonstrate a more flexible sustainability paradigm that goes beyond technical efficiency to embrace cultural practices and local knowledge. The specific strategies applied to these private projects are summarized in Table 6.

Figure 2

Elevated Structure Designed to Preserve the Surrounding Ecosystem

Note. This figure demonstrates elevated structures in the case studies intended to preserve the existing ecosytems. From *Tribune VVIP F1*, by Mamo Studio, 2023, Mamo Studio (https://mamostudio.id/project/tribune-vvip-f1/). Copyright 2023 by Mamo Studio. From *Forest Walk Babakan Siliwangi-IAI Jabar Awards Board*, by APTA Studio, 2021. Copyright 2021 by APTA Studio. The material was obtained from the awarding board as part of the architect’s project documentation.

Table 6

Thematic Design Strategy in Private Sector Projects

Thematic design strategy for sustainability (GBRT aligned)	Architect	Awarded Project	Design Strategy
Building resiliency and adaptability (3 strategies)			
Building adaptive reuse	AR-2	Riau 20	Introducing new program into an existing building
Construction that avoids altering existing conditions	AR-2	Riau 20	Lightweight structural system
Construction that avoids altering existing conditions	AR-2	Riau 20	Insertion of new columns without penetrations through existing walls
Energy efficiency (3 strategies)			
Passive design strategies	AR-1	Pahoa Kindergarten	Natural ventilation
Passive design strategies	AR-2	Riau 20	Natural ventilation
Passive design strategies	AR-4	Lego Mosque/Masjid Al-Fattah	Natural ventilation
Passive design strategies	AR-4	Lego Mosque/Masjid Al-Fattah	Daylighting strategy
Locally based architectural strategies for passive design	AR-4	Lego Mosque/Masjid Al-Fattah	Breathable wall assembly
Indoor health and comfort (1 strategy)			
Thermal comfort	AR-4	Lego Mosque/Masjid Al-Fattah	Thermal comfort
Material resources and cycle (6 strategies)			
Reuse of existing/on-site materials	AR-2	Riau 20	Existing/on-site materials
Reuse of existing/on-site materials	AR-2	Riau 20	Existing architectural elements
Unfired brick	AR-4	Lego Mosque/Masjid Al-Fattah	Unfired laterite brick
Waste-derived materials	AR-4	Lego Mosque/Masjid Al-Fattah	Terracotta-waste–based materials
Modular materials	AR-4	Lego Mosque/Masjid Al-Fattah	Interlocking masonry units
Local material producers	AR-4	Lego Mosque/Masjid Al-Fattah	Local brick producers
Sustainable site development (8 strategies)			
Green spaces	AR-1	Pahoa Kindergarten	Green/open space
Reducing building impact on site	AR-1	Pahoa Kindergarten	Minimizing site coverage (building footprint)
Preserving existing ecosystems	AR-6	Dusun Bambu	Ecosystem conservation
Preserving existing ecosystems	AR-6	Dusun Bambu	Replanting endemic vegetation
Preserving existing ecosystems	AR-6	Dusun Bambu	Protecting legally protected endemic species
Preserving existing ecosystems	AR-6	Dusun Bambu	Elevated structure to protect vegetation
Development on degraded/“negative-value” land	AR-6	Dusun Bambu	Remediation of degraded land
Natural ecosystems for local self-sufficiency	AR-6	Dusun Bambu	Ecosystem-based local self-sufficiency

Table 6 (Continued)

Thematic design strategy for sustainability (Local-contextual themes)	Architect	Awarded Project	Design Strategy
Cultural values (5 strategies)			
Inspiration/translation from traditional/vernacular architecture	AR-4	Lego Mosque/Masjid Al-Fattah	*Tumpang sari* motif expressed in concrete at the roof
	AR-6	Dusun Bambu	Representation of ecosystems and cultural cosmology
			Site layout guided by Sundanese hamlet cosmology
			Form inspired by traditional Sundanese dwelling typologies
Cultural narratives			Sundanese cultural narrative
Human-centered design (1 strategy)			
User safety and comfort considerations	AR-1	Pahoa Kindergarten	Design considerations for child safety
Social collaboration in the design process (1 strategy)			
Community and local artisan participation	AR-2	Dusun Bambu	Involvement of the local community in construction
Socio-Economic & Community Value (1 strategy)			
Exploration of local community cultural values	AR-6	Dusun Bambu	Design input from the adat (customary) village authority

In cases such as the Lego Mosque and Dusun Bambu, architects collaborated with local craftsmen through a series of practices, including the exchange of tacit knowledge, guided material handling, and hands-on construction detailing. Through this process, local craftsmanship was elevated as a core dimension of context-responsive design, as illustrated in Figure 3, For the Lego Mosque, the architect notes, “With the lego bricks, the practice explored the tectonics of brick. Three brick types were used...a half unit so bricks no longer needed to be cut, and a channeled unit...providing space for mortar or reinforcement” (AR-4, personal communication, October 28, 2024).

The bricks were then assembled as a “breathing wall,” where “the lego bricks form a breathing wall with perforations that let air flow freely inside. Thus, the mosque does not use air-conditioning” (AR-4). Meanwhile, at Dusun Bambu, the architects co-built with craftsmen from Kampung Naga, “For the traditional buildings we collaborated with craftsmen from Kampung Naga; they were the ones who built them,” and sought design input through field visits to Kampung Naga, Ciptagelar, and Banten “to gather input on what visitors should experience in a place that feels deeply Sundanese” (AR-6, personal communication, March 13, 2025).

Material selection in private projects follows a logic of proximity and availability, aligning practicality with resource efficiency and circularity. At the Lego Mosque, the team used 100% non-fired interlocking bricks and roster block from recycled terracotta waste. As the architect explains, “This mosque is built with 100% non-fired bricks...The process without firing reduces carbon emissions into the atmosphere…while the roster blocks are produced from recycled terracotta waste” (AR-4, personal communication, October 28, 2024).

The adaptive reuse of Riau 20 extends this circular logic through light-touch construction and retention of architectural elements and materials of the heritage building. As stated by the architect,

> *"*The new service block uses lightweight steel and hollow sections, with new columns set within the boundary wall so we did not breach the existing walls...The architectural elements and materials of the existing heritage building were preserved and became part of the building's identity*."*
>
> (AR-2, personal communication, November 14, 2024).

In ecotourism, Dusun Bambu reframes vernacular sustainability as ecological stewardship. The architect notes*, "*The land had been degraded…We restored the soil, made a river and a lake, and replanted with endemic vegetation*"* (AR-6, personal communication, March 13, 2025). Collaboration with researchers from Bogor Agricultural University also guided bamboo cultivation: *"*We worked with IPB to establish a bamboo collection…In the end, bambu bongbong grew fastest and re-greened the degraded soils*"* (AR-6, personal communication, March 13, 2025). By aligning with the ecological wisdom of *desa adat*, conceived as self-sustaining ecosystems where daily life is supported by rice fields, ponds, gardens, and forests, the project ensured material reliability while safeguarding long-term ecological integrity, as illustrated in Figure 4.

CSR-NGO Projects

CSR–NGO work positions architects as mediators who convert the logics of local building traditions into functional strategies calibrated to community skills and uses, addressing long-standing local challenges, as shown in Figure 5. At STT Makedonia, the architect recalls, *"*What I took was not the form, but how they filtered air in the longhouse...using clerestory vents (*angin-angin*)" (AR-2, personal communication, November 14, 2024). Participation shaped not only construction but also identity, as the architect *"*gave the vision, and the students made the mural...so they felt ownership*"* (AR-2, personal communication, November 14, 2024). Meanwhile, local builders were empowered to adapt details: "The carpenter said, 'Sir, can I add this?' I agreed... because it fit the context" (AR-2, personal communication, November 14, 2024).

The design also drew on local traditions to address flooding by "implementing the elevated stilt form but in concrete" (AR-2, personal communication, November 14, 2024). At the Eagle School in Rote, this ethos extended to material and labor practices, "We used local materials…mostly lontar wood, foundations from tree trunks, walls from palm fronds" and, crucially, "The builders were local people, we trained them and they were the ones who built it" (AR-6, personal communication, March 13, 2025). Here, resilience is operationalized as the ability to repair and maintain with familiar resources and skills.

Figure 3

Local Craftmanship in Material Treatment and Construction Detailing

Note. This figure illustrates local craftsmanship in the Lego Mosque through material treatment and construction detailing. From *Material Treatment and Construction Detailing*, by Andy Rahman, 2024, Threads (https://www.threads.com/@andyrahman/post/C9psvG0v756). Copyright 2024 by Andy Rahman.

Figure 4

Self-Sustaining Ecosytems Inspired by Traditional Villages

Note. This figure demonstrates how local knowledge on creating self-sustaining ecosystems informed the design of the Dusun Bambu eco-tourism site. From *Dusun Bambu-IAI Jabar Awards Board documentation,* by APTA Studio*,* 2021*.* Copyright 2021 by APTA Studio*.* The material was obtained from the awarding board as part of the architect's project documentation

Figure 5

Architectural Interventions Rooted in Local Building Traditions

Note. This figure demonstrates local building tradition that inspired ecological support and social resilience in the STT Makedonia and Eagle School projects. From *STT Makedonia*, by Hepta Desain, 2023, Instagram (https://www.instagram.com/heptadesain/). Copyright 2023 by Hepta Desain. From *Eagle School – IAI Jabar Awards Board documentation*, by APTA Studio, 2021. Copyright 2021 by APTA Studio. The material was obtained from the awarding board as part of the architect's project documentation. From *Rumah Tradisional Pulau Rote*, by Rotendaokab, 2010, Pemerintah Kabupaten Rote Ndao (https://rotendaokab.go.id/topik/rumah-tradisional-pulau-rote). Copyright 2019 by Rotendaokab.

The Ocean of Life Learning Center further integrates local ecological cycles into building systems. According to the architect, "Rainwater is collected, filtered, and reused in fish ponds and to water the garden…Organic waste mixed with cow dung produces biogas for cooking" and "The slurry is used as organic fertilizer for agriculture" (AR-3, personal communication, October 15, 2024).

Such closed-loop practices extend principles of circularity into contemporary ecotourism facilities. Coupled with a locally sourced material palette, familiar building forms and techniques, and community participation in construction, these systems build operational resilience that enables communities to maintain, repair, and reconstruct their environment independently. In this framing, sustainability is operationalized as post-handover capacity-building by strengthening community ability to build and maintain with existing local labor, traditional techniques, and readily available materials. The sustainability strategy themes in CSR–NGO projects are summarized in Table 7.

Table 7

Thematic Design Strategy in CSR-NGO Projects

Thematic design strategy for sustainability (GBRT aligned)	Architect	Awarded Project	Design Strategy
Building resiliency and adaptability (3 strategies)			
Spatial adaptability	AR-6	Eagle School	Adaptable spatial function
Building adaptive reuse	AR-3	Rumah Belajar Lingkungan Ocean of Life Indonesia	Introducing new program into an existing building
Building resilience to hazards/disasters	AR-2	STT Makedonia	Elevated/stilted structure for flood resilience
Energy efficiency (3 strategies)			
Renewable energy	AR-3	Rumah Belajar Lingkungan Ocean of Life Indonesia	Biogas energy system
Locally based architectural strategies for passive design	AR-2	STT Makedonia	Local strategy-inspired *angin-angin* (transom vent)
Passive design strategies			Natural ventilation
Indoor health and comfort (2 strategies)			
Locally based strategies for visual comfort	AR-2	STT Makedonia	*Gedheg* (bamboo woven) wall adaptation for visual privacy
Views of nature	AR-3	Rumah Belajar Lingkungan Ocean of Life Indonesia	Orientation to sea views
Material resources and cycle (7 strategies)			
Modular materials	AR-2	STT Makedonia	Modular timber components
Local materials			*Ulin* (ironwood) and *keladan*
	AR-3	Rumah Belajar Lingkungan Ocean of Life Indonesia	Locally sourced, community-grown timber
			Locally quarried karst stone
	AR-6	Eagle School	Coconut and lontar palms
Self-managed/on-site material production			Self-fabricated materials
			Concrete block molds

Table 7 (Continued)

Thematic design strategy for sustainability (GBRT aligned)	Architect	Awarded Project	Design Strategy
Sustainable site development (3 strategies)			
Reducing building impact on site	AR-2	STT Makedonia	Building elevation follows site contours
Organic land management	AR-3	Rumah Belajar Lingkungan Ocean of Life Indonesia	Bioslurry used as agricultural fertilizer
Productive land management			Permaculture
Water conservation (3strategies)			
Greywater recycling	AR-3	Rumah Belajar Lingkungan Ocean of Life Indonesia	Greywater reuse for landscaping and ponds
			Greywater filtration
Rainwater harvesting			Rainwater harvesting
Thematic design strategy for sustainability(Local-contextual themes)	**Architect**	**Awarded Project**	**Design Strategy**
Cultural values (3 strategies)			
Cultural narratives	AR-2	STT Makedonia	Tree of Life motif
Inspiration/translation from traditional/vernacular architecture			Longhouse (*rumah panjang*) as a form-giving reference
	AR-6	Eagle School	Form inspired by local dwelling typologies
Social collaboration in the design process (6 strategies)			
Co-design with artisan builders/contractors	AR-6	Eagle School	Design exploration with craftspeople/artisans
Training for local artisan			Training for craftspeople
Co-design with artisan builders/contractors	AR-2	STT Makedonia	Design exploration with craftspeople/artisans
Artisan knowledge and skills			Local knowledge and skills
Community and local artisan participation			Student participation
			Community participation
	AR-3	Rumah Belajar Lingkungan Ocean of Life Indonesia	

Individual Projects

Small individual commissions, residential (Rumah Kayu Ciledug, Mess Buruh Cengklong, Omah Boto, Omah Amoh) and small commercial (Warung Pengepul Kayu, LMBG Officafe), show that sustainability in Indonesia emerges through the negotiation of everyday constraints. Sited on narrow, irregular, often marginal plots within dense urban fabrics, these works favor site-responsive, incremental tactics over formal rating compliance. Architect of Rumah Kayu Ciledug explains,

> "Instead of a perpendicular layout, the plan was rotated by seven degrees to create space for air and light to flow in and out of the house" while budget limits drove the reuse of "second-hand timber and clay tiles from the old house"
>
> (AR-3, personal communication, October 15, 2024).

Similarly, in Mess Buruh Cengklong, cost efficiency shaped material choices: "All walls use exposed red brick to save both material and maintenance costs" (AR-3, personal communication, October 15, 2024). Collaboration is pivotal, with architects engaging local builders and craftsmen as co-designers, whose tacit knowledge informs material selection, detailing, and finishes, as shown in Figure 6. At Omah Boto, the architect describes how "the façade took three months to complete, with every brick woven one by one" (AR-4, personal communication, October 28, 2024), a process that demanded meticulous craftsmanship and close collaboration with the craftsmen: "We invited the builders as design partners, so they too felt like subjects determining whether the design succeeded" (AR-4, personal communication, October 28, 2024).

Cultural integration reimagines traditional forms and construction logics as contemporary expressions that retain familiarity and emotional resonance, as shown in Figure 7. In Omah Boto, the architect transformed the Javanese house sequence into a vertical composition: "the first floor as *pendopo*, the second as *pringgitan*, and the third as *omah dalem*" (AR-4, personal communication, October 28, 2024), while brick patterns drew from batik motifs such as *parang* and *kawung*. In Warung Pengepul Kayu, the architect frames the reuse practice within a cultural logic of creativity: "Second-life materials—steel, timber, marble, even old tiles—were reconstructed into a new café identity" (AR-6, personal communication, March 13, 2025).

In these individual projects, sustainability is socially co-produced and culturally embedded: grounded in everyday economies, enabled by builder collaboration, and articulated through material reuse and the transformation of vernacular logics into contemporary design languages. The design strategy details in individual projects are summarized in Table 8.

Figure 6

Integrating Locally Rooted Craftmanship through Design-Build Collaboration

Note. This figure demonstrates the craftsmanship of local artisans and builders, providing information on material selection, construction detailing, and finishing. From *Omah Boto*, by Andyrahman architect, 2019, Archify (https://www.archify.com/id/project/omah-boto). Copyright 2019 by Mansyur Hasan and Andyrahman architect.

Figure 7

Cultural Integration Through the Reinterpretation of Traditional Forms and Construction Logics as Contemporary Expressions

Note. This figure demonstrates the reinterpretation of vernacular architectural elements in residential projects. From *Rumah Kayu Ciledug 05*, by Akanoma, 2012, Facebook (https://www.facebook.com/media/set/?set=a.296010933844315&type=3). Copyright 2012 by Akanoma. From *The Obsolete House (Omah Amoh),* by Gayuh Budi Utomo, 2016, ArchDaily (https://www.archdaily.com/908906/the-obsolete-house-omah-amoh-gayuh-budi-utomo). Copyright 2016 by Mansyur Hasan.

Table 8

Thematic Design Strategy in Individual Projects

Thematic design strategy for sustainability (GBRT aligned)	Architect	Awarded Project	Design Strategy
Building resiliency and adaptability (2 strategies)			
Spatial adaptability	AR-3	Rumah Kayu Ciledug	Adaptable spatial function
	AR-5	Obsolete House/Omah Amoh	
			Flexible non-partitioned space
Energy efficiency (5 strategies)			
Passive design strategies	AR-3	Mess Buruh Cengklong	Daylighting strategy
		Rumah Kayu Ciledug	

Table 8 (Continued)

Thematic design strategy for sustainability (GBRT aligned)	Architect	Awarded Project	Design Strategy
			Site-responsive plan orientation
	AR-4	Omah Boto	Vegetation for microclimate regulation
			Integrated architecture and landscape
Locally based architectural strategies for passive design			Transformation of *gedheg* (bamboo woven) wall to transmit airflow
Indoor health and comfort (2 strategies)			
Locally based strategies for visual comfort	AR-4	Omah Boto	*Gedheg* (woven bamboo) wall adaptation for visual privacy
			Glare reduction through modified *gedheg* (bamboo woven) wall
Material resources and cycle (14 strategies)			
Reuse of existing/on-site materials	AR-3	Rumah Kayu Ciledug	Existing clay roof tiles retained
Material efficiency		Mess Buruh Cengklong	Exposed fired-brick finish
		Rumah Kayu Ciledug	Thin-coat plaster to reduce material consumption
			Simplified roof form
Salvaged building materials			Reclaimed-timber construction
	AR-5	Obsolete House/Omah Amoh	Reused doors
			Reclaimed materials
	AR-6	Warung Pengepul Kayu	
Industrial materials		LMBG Officafe	Exploration of engineered wood products
Innovations in timber connections/joinery			Local timber joinery techniques
Construction cost efficiency		Warung Pengepul Kayu	Construction cost optimization
Local materials			Short supply chains (proximity-based logistics)
	AR-4	Omah Boto	Bamboo, timber and rattan
Modular materials			Brick module used as the dimensional grid
Waste-derived materials		Lego Mosque/Masjid Al-Fattah	Terracotta-waste–based materials

Table 8 (Continued)

Thematic design strategy for sustainability (GBRT aligned)	Architect	Awarded Project	Design Strategy
Sustainable site development (3 strategies)			
Nature-based water management	AR-6	LMBG Officafe	Stilt houses to preserve infiltration zones
Productive land management	AR-3	Mess Buruh Cengklong	Cultivation plots
Development on degraded/“negative-value” land			Former landfill site
Thematic design strategy for sustainability (Local-contextual themes)	**Architect**	**Awarded Project**	**Design Strategy**
Cultural values (5 strategies)			
Brick patterning inspired by traditional decorative elements	AR-4	Omah Boto	Brick pattern inspired by batik motifs
Inspiration/translation from traditional/vernacular architecture			Transformation of Javanese house spatial organization
	AR-3	Rumah Kayu Ciledug	Javanese house (*rumah Jawa*)–inspired roof
Communal spaces		Mess Buruh Cengklong	Social space
	AR-5	Obsolete house/Omah Amoh	
Canonical elements of traditional architecture			Canonical elements of the traditional *gebyok* (carved Javanese screen)
Social collaboration in the design process (4 strategies)			
Artisan knowledge and skills	AR-4	Omah Boto	Bricklaying skills
			Craftsmanship precision and accuracy
Co-design with artisan builders/contractors			Design exploration with craftspeople/artisans
	AR-6	Warung Pengepul Kayu	
		LMBG Officafe	Discussions with the contractor

DISCUSSION

Tensions between Global Rating Frameworks and Low-Tech Strategies

GBRTs provide standardized, measurable parameters for energy, water, and materials. Their strength is comparability through common standards; however, their technocratic orientation privileges high-tech solutions, performance modeling, and certified supply chains (Berardi, 2015; Pareti et al., 2022; Vyas & Jha, 2016). While these metrics convey objectivity, they also sideline context-responsive, resource-efficient practices. In the Global South, including Indonesia, they often overlook local resource availability, vernacular know-how, and community-based construction. Consequently, place-based strategies struggle to align with frameworks calibrated to high-performance specifications and certification (Mastrucci, 2019; Musa & Burgess, 2022; Shan & Hwang, 2018; Tuhkanen et al., 2022; Varma & Palaniappan, 2019).

Our findings show that Indonesian architects, particularly in small to medium-scale private and community projects, advance sustainability through low-tech, community-based strategies—cross-ventilation, adaptive reuse of local and recycled materials, flood-ready stilted forms, and resource loops such as bamboo cultivation or terracotta waste reuse. These practices, rooted in vernacular logics, are both climate-responsive and culturally embedded, aligning building performance with local ecologies and communal life rather than narrowly technical metrics (Hanan & Wonorahardjo, 2012; Memmott et al., 2023; Pareti et al., 2022; Rashid & Ara, 2015; Salman, 2019; Sirror, 2024). Such strategies are climate-responsive and embedded in culturally specific social practices and communal ways of life that deliver sustainability beyond narrowly technical performance (Memmott & Keys, 2015; Nielsen, 2022; Olukoya & Atanda, 2020; Wu et al., 2016). At this scale, where architects have greater autonomy, cultural integration and social collaboration are most consistently realized. Social collaboration through community partnerships activates local knowledge and maintenance capacity (Iwuanyanwu et al., 2024; Jeannotte & Duxbury, 2015; Wali et al., 2017). In contrast, large-scale and regulation-driven projects typically reduce sustainability to compliance, resource accounting, site-level mitigation, and a checklist of regulations, while sidelining socio-cultural dynamics and curtailing opportunities for contextual innovation (Kementerian PUPR, 2021; Ministry of Public Works and Housing (PUPR), 2024).

Such privileging, in turn, reorganizes what counts as sustainability in assessment, often excluding situated performance and social-technical collaboration. Accordingly, this discussion maps how global rating systems and Indonesian architectural practice construct sustainability differently. Across energy efficiency, material resources and cycles, indoor health and comfort, water conservation, sustainable site development, and building resiliency and adaptability, a recurring gap emerges between GBRTs' measurable proxies and architects' context-driven values.

Energy efficiency illustrates a recurring misalignment between GBRT assessments and Indonesian practice. Global frameworks define performance through energy modeling against HVAC-centric baselines and credits for commissioning or metering, privileging sealed, mechanically conditioned envelopes (Building Research Establishment, 2021; Chokor et al., 2016; Council, 2014). Indonesian architects, by contrast, routinely lower cooling demand with low-tech passive logics—cross-ventilation, stack effect, operable windows, breathable *gedheg* walls, and vegetation-based microclimate regulation—which often achieve greater reductions in operation but remain poorly convertible into simulation credits that prioritize modeled savings over adaptive comfort (Dear, 2020; Ge et al., 2024; Jiang et al., 2023). Indonesia's government-developed tool, PKBGH, has attempted to address this mismatch by awarding credits for naturally ventilated buildings, but in global frameworks, simulation-based energy credits remain the dominant measure. Materials resources and cycles provide a parallel case. GBRTs equate responsibility with industrial traceability—EPDs, FSC, LCA documentation, or TKDN thresholds (Building Research Establishment, 2021; Greenship, 2024; Kementerian PUPR, 2021; USGBC, 2025). Indonesian practice, however, mobilizes proximate, circular, and vernacular flows such as salvaged timber, terracotta reuse, bamboo cultivation, or crafts-based fabrication. These reduce embodied carbon, sustain cultural knowledge, and support local economies, yet without certificates they remain invisible to rating systems (Devos et al., 2024; Gan et al., 2022; Ray et al., 2021).

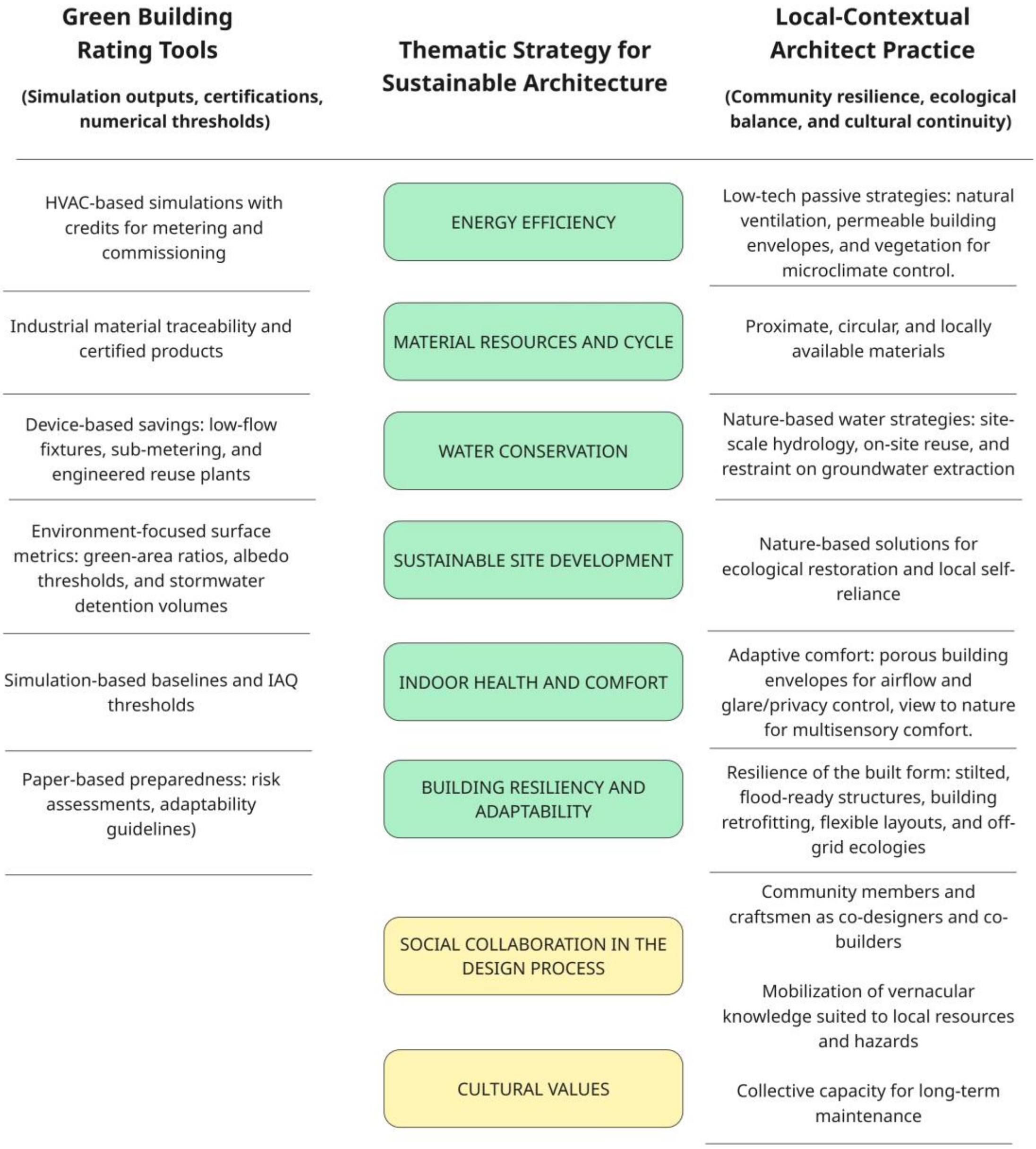
A similar gap persists in water conservation and sustainable site development strategies: Whereas GBRTs privilege device-based accounting, flow rates, or surface green ratios (Building Research Establishment, 2021; Greenship, 2024; USGBC, 2025). Indonesian projects advance hydrological sensitivity and ecological restoration—rainwater terracing, filtration ponds, aquaculture, stilted structures preserving infiltration, permaculture beds, and soil rehabilitation—practices that embed traditional ecological knowledge and sustain livelihoods but elude recognition within narrowly quantified credits (Utami et al., 2022; Walker et al., 2024).

Indoor health and comfort, building resiliency and adaptability, and cultural values further expose the limits of GBRT measurability. Comfort is typically assessed through ASHRAE 55 bands or SNI equivalents with simulations for daylight and IAQ (Greenship, 2024; Sujanova et al., 2019; USGBC, 2025; Wardhani & Susan, 2019), while Indonesian practice treats it as adaptive and multisensory: Porous walls temper glare while admitting breezes, bamboo and brick screens diffuse light with privacy, and broad openings choreograph airflow and views. Building resiliency and adaptability is often reduced in GBRTs to documented preparedness (risk registers or guideline checklists) rather than embodied transformation in design and use (De Castro & Kim, 2021; Roostaie et al., 2021). In Indonesian practice, however, resilience is materially and spatially enacted through stilted forms that anticipate flooding, adaptive reuse of existing structures, reconfigurable layouts that accommodate shifting programs, and off-grid ecologies such as biogas or permaculture that diversify risk. Crucially, these technical and spatial strategies are inseparable from social collaboration in the design process, where communities act as co-designers and co-builders, mobilizing vernacular knowledge, resource-sharing networks, and collective responsibility to ensure that buildings are not only delivered but also maintained and adapted over time (Correia et al., 2023; Memmott et al., 2023). Cultural values are considered: Translations of vernacular logics, *rumah panggung*, bamboo and terracotta as building envelopes, and cosmology-informed spatial hierarchies, do not merely symbolize identity; they tune buildings to climate and stewardship norms that underpin long-term care.

Taken together, these frictions show that the metrics most visible to GBRTs—simulation outputs, certifications, and numerical thresholds—do not consistently capture what practice values on the ground—community resilience, ecological balance, and cultural continuity— as shown in Figure 8. In Indonesia, a context-aligned recalibration—recognizing passive/adaptive comfort, accounting for proximate and vernacular material cycles, and crediting community-centered resilience through co-design and incremental phasing—can keep GBRTs rigorous yet genuinely responsive to climatic logics, cultural values, and stewardship norms

Figure 8

Comparison of GBRTs and Local-Contextual Strategies in Sustainable Architecture



CONCLUSION

This study demonstrates that global green building rating tools (GBRTs) often overlook the cultural, ecological, and social complexities that underpin sustainability in Indonesia. While GBRTs provide measurable and comparable standards, their technocratic orientation privileges high-tech simulations, industrial certifications, and prescriptive thresholds—narrowing sustainability to what can be easily audited rather than what demonstrably sustains. By contrast, Indonesian practice reveals sustainability as an integrated process that combines low-tech and vernacular strategies, community participation, and ecological balance embedded in everyday life.

The findings further show that project type and governance shape how contextual strategies are applied. In small- to medium-scale private and CSR projects, architects exercise greater autonomy to embed passive cooling, proximate/vernacular material cycles, and community collaboration. By contrast, in larger, regulation-led government projects, architects are constrained by compliance requirements that tend to reduce sustainability to resource accounting and site-level mitigation, often at the expense of socio-cultural dimensions. Advancing a more inclusive model of sustainable architecture in Indonesia requires a two-track recalibration: (1) Standards and evidence – Recognize adaptive comfort pathways, proximate/vernacular material cycles, and participatory processes as legitimate evidence of performance; and (2) Policy and governance – Enable regulatory frameworks that legitimize and scale low-tech, context-sensitive practices without sacrificing rigor. Future comparative research between community-driven and large-scale public projects is essential to identify not only context-adaptive innovations but also the structural barriers and regulatory frictions that limit their wider recognition. Such work can inform policy reforms that align certification metrics with what truly sustains—community resilience, ecological balance, and cultural continuity.

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REFERENCES

Ahuja, S., & Weatherall, R. (2023). “This boys club world is finally getting to me”: Developing our glass consciousness to understand women’s experiences in elite architecture firms. *Gender, Work & Organization*, *30*(3), 826–841. https://doi.org/10.1111/gwao.12921

Andracana, I. G. N. (2023). Green thinking of indonesian architects. *Iop Conference Series Earth and Environmental Science*, *1169*, Article 012070. https://doi.org/10.1088/1755-1315/1169/1/012070

Awadh, O. (2017). Sustainability and green building rating systems: LEED, BREEAM, GSAS and Estidama critical analysis. *Journal of Building Engineering*, *11*(10), 25–29. https://doi.org/10.1016/j.jobe.2017.03.010

Berardi, U. (2015). Sustainability assessments of buildings, communities, and cities. In J. J. Klemes (Ed.), *Assessing and measuring environmental impact and sustainability* (pp. 497–545). Butterworth-Heinemann. https://doi.org/10.1016/B978-0-12-799968-5.00015-4

Bryman, A. (2016). *Social research methods*. Oxford university press.

Building Research Establishment. (2021). *Technical manual: BREEAM international new construction, version 6.0*. https://breeam.com/breeam-infrastructure/technical-manuals/version-6

Chapman, A., Hadfield, M., & Chapman, C. (2015). Qualitative research in healthcare: An introduction to grounded theory using thematic analysis. *Journal of the Royal College of Physicians of Edinburgh*, *45*(3), 201–205. https://doi.org/10.4997/jrcpe.2015.305

Chokor, A., El Asmar, M., Tilton, C., & Srour, I. (2016). Dual assessment framework to evaluate LEED-certified facilities' occupant satisfaction and energy performance: Macro and micro approaches. *Journal of Architectural Engineering*, *22*(4). https://doi.org/10.1061/(ASCE)AE.1943-5568.0000186

Correia, M., Juvanec, B., Mileto, C., Vegas, F., Gomes, F., Alcindor, M., & Lima, A. (2023). Socio-economic sustainability in vernacular architecture. In M. Correia, L. Dipasquale, & S. Mecca (Eds.), *VerSus: Heritage for tomorrow. Vernacular knowledge for sustainable architecture* (pp. 56–63). Firenze University Press. https://media.fupress.com/files/pdf/24/2920/2920_7032

Cross, N. (2023). *Design thinking: Understanding how designers think and work*. Bloomsbury Publishing.

Daly, S. R., Yilmaz, S., Christian, J. L., Seifert, C. M., & Gonzalez, R. (2012). Design heuristics in engineering. *Journal of Engineering Education*, *101*(4), 601–629. https://doi.org/10.1002/j.2168-9830.2012.tb01121.x

De Castro, D., & Kim, A. (2021). Adaptive or absent: A critical review of building system resilience in the LEED rating system. *Sustainability*, *13*(12), Article 6697. https://doi.org/10.3390/su13126697

Dear, R. de. (2020). A review of adaptive thermal comfort research since 1998. *Energy and Buildings*, 214, Article 109893. https://doi.org/10.1016/j.enbuild.2020.109893

Devos, K., Devlieger, L., & Steeman, M. (2024). Reclaimed or new? Life cycle assessment of ceramic bricks. *Journal of Cleaner Production*, *476,* Article 143764. https://doi.org/10.1016/j.jclepro.2024.143764

Diaz-Sarachaga, J. M., Jato-Espino, D., & Castro-Fresno, D. (2017). Methodology for the development of a new sustainable infrastructure rating system for developing countries (SIRSDEC). *Environmental Science & Policy*, *69*, 65–72. https://doi.org/10.1016/j.envsci.2016.12.010

Gan, J., Chen, M., Semple, K., Liu, X., Dai, C., & Tu, Q. (2022). Life cycle assessment of bamboo products: Review and harmonization. *Science of The Total Environment*, *849*, Article 157937. https://doi.org/10.1016/j.scitotenv.2022.157937

Ge, J., Wang, Y., Zhou, D., Gu, Z., & Meng, X. (2024). Effects of urban vegetation on microclimate and building energy demand in winter: An evaluation using coupled simulations. *Sustainable Cities and Society*, *102*, Article 105199. https://doi.org/10.1016/j.scs.2024.105199

Gramkow, M. C., Merit, M. T., & Stigsdotter, U. K. (2022). A qualitative study on how Danish landscape architectural firms understand and work with accessibility. *Archnet-IJAR: International Journal of Architectural Research*, *16*(3), 536–553. https://doi.org/10.1108/ARCH-08-2021-0233

Green Building Council Indonesia. (2024). *GREENSHIP new building v1.2 (Green building rating tool).* https://gbcindonesia.org/files/resource/9b552832-b500-4b73-8c0e-acfaa1434731/Summary%20GREENSHIP%20New%20Building%20V1.2.pdf

Griffiths, K., Boyle, C., & Henning, T. F. P. (2018). Beyond the certification badge—how infrastructure sustainability rating tools impact on individual, organizational, and industry practice. *Sustainability*, *10*(4), Article 1038. https://doi.org/10.3390/su10041038

Hanan, H., & Wonorahardjo, S. (2012). The architecture of Batak Toba: An expression of living harmoniously. *Nakhara: Journal of Environmental Design and Planning*, *8*, 11–21. https://ph01.tci-thaijo.org/index.php/nakhara/article/view/104899

Hartley, K. (2020). The epistemics of policymaking: From technocracy to critical pragmatism in the UN sustainable development goals. *International Review of Public Policy*, *2*(2), 233–244. https://doi.org/10.4000/irpp.1242

Illankoon, I. M. C. S., Tam, V. W. Y., Le, K. N., Tran, C. N. N., & Ma, M. (2019). Review on green building rating tools worldwide: recommendations for Australia. *Journal of Civil Engineering and Management*, *25*(8), 831–847. https://doi.org/10.3846/jcem.2019.10928

Isaksson, R., Rosvall, M., Espuny, M., Nunhes, T. V., & de Oliveira, O. J. (2022). How is building sustainability understood? A study of research papers and sustainability reports. *Sustainability*, *14*(19), Article 12430. https://doi.org/10.3390/su141912430

Iwuanyanwu, O., Gil-Ozoudeh, I., Okwandu, A. C., & Ike, C. S. (2024). Cultural and social dimensions of green architecture: Designing for sustainability and community well-being. *International Journal of Applied Research in Social Sciences*, *6*(8), 1951–1968. https://doi.org/10.51594/ijarss.v6i8.1477

Jeannotte, M. S., & Duxbury, N. (2015). Advancing knowledge through grassroots experiments: Connecting culture and sustainability. *The Journal of Arts Management, Law, and Society*, *45*(2), 84–99. https://doi.org/10.1080/10632921.2015.1039739

Jiang, Z., Kobayashi, T., Yamanaka, T., & Sandberg, M. (2023). A literature review of cross ventilation in buildings. *Energy and Buildings*, *291*, Article 113143. https://doi.org/10.1016/j.enbuild.2023.113143

Junaidy, D. W., & Nagai, Y. (2017). The characteristic of thought of digital architects. *International Journal of Creative Future and Heritage (TENIAT)*, *5*(1), 41–73. https://doi.org/10.47252/teniat.v5i1.210

Khan, J. S., Zakaria, R., Shamsudin, S. M., Abidin, N. I. A., Sahamir, S. R., Abbas, D. N., & Aminudin, E. (2019). Evolution to emergence of green buildings: A review. *Administrative Sciences*, *9*(1), Article 6. https://doi.org/10.3390/admsci9010006

Kusno, A. (2010a). *The appearances of memory: Mnemonic practices of architecture and urban form in Indonesia*. Duke University Press.

Kusno, A. (2010b). Tropics of discourse: Notes on the re-invention of architectural regionalism in Southeast Asia in the 1980s. *Fabrications*, *19*(2), 58–81. https://doi.org/10.1080/10331867.2010.10539658

Lam, W. H., Wong, C. F., Tan, O. K., & Yap, B. H. (2024). Study on the benefits of the implementation of green building rating in Malaysia. *The Journal of The Institution of Engineers Malaysia*, *85*(1), 17–24. https://doi.org/10.54552/v85i1.226

Lee, J. W., Daly, S. R., Huang-Saad, A., Rodriguez, G., & Seifert, C. M. (2020). Cognitive strategies in solution mapping: How engineering designers identify problems for technological solutions. *Design Studies*, *71*, Article 100967. https://doi.org/10.1016/j.destud.2020.100967

Li, S., & Qu, F. (2022). Preserving authenticity in urban regeneration: A framework for the new definition from the perspective of multi-subject stakeholders—a case study of Nantou in Shenzhen, China. *International Journal of Environmental Research and Public Health*, *19*(15), Article 9135. https://doi.org/10.3390/ijerph19159135

Liu, F., & Kang, J. (2016). A grounded theory approach to the subjective understanding of urban soundscape in Sheffield. *Cities*, *50*, 28–39. https://doi.org/10.1016/j.cities.2015.08.002

Makwaney, D. (2021). *The Pritzker Prize for architects: A critical analysis of gender and identity* [Master's thesis, Deakin University]. ResearchGate. https://www.researchgate.net/publication/350371544.

Marshall, B., Cardon, P., Poddar, A., & Fontenot, R. (2013). Does sample size matter in qualitative research? A review of qualitative interviews in is research. *Journal of Computer Information Systems*, *54*(1), 11–22. https://doi.org/10.1080/08874417.2013.11645667

Mastrucci, A. (2019). Improving the SDG energy poverty targets: Residential cooling needs in the Global South. *Energy and Buildings*, *186*, 405–415. https://doi.org/10.1016/j.enbuild.2019.01.015

Memmott, P., & Keys, C. (2015). Redefining architecture to accommodate cultural difference: Designing for cultural sustainability. *Architectural Science Review*, *58*(4), 278–289. https://doi.org/10.1080/00038628.2015.1032210

Memmott, P., Vellinga, M., O'Rourke, T., & Ting, J. (2023). *Design and the vernacular: Interpretations for contemporary architectural practice and theory*. Bloomsbury Visual Arts

Ministry of Public Works and Housing of the Republic of Indonesia. (2021). *Regulation of the Minister of Public Works and Housing of the Republic of Indonesia No. 21 of 2021 on green building performance assessment*. Ministry of Public Works and Housing of the Republic of Indonesia.

Ministry of Public Works and Housing of the Republic of Indonesia. (2024). *Roadmap for the implementation and guidance of green building (GB) development*. https://ciptakarya.pu.go.id/admin/assets/upload/file/laporan/2024/10/10/205512_PETA%20JALAN%20PENYELENGGARAAN%20PEMBINAAN%20BGH_OKT%202024.pdf

Musa, C., & Burgess, G. (2022). *Beyond policy change: The complexity of transitioning to alternative building materials in informal settlements*. Reginal Studies Association. https://doi.org/10.1080/13673882.2023.00001002

Nabilunnuha, M. B., Hervanda, S., Xian, G. E., Tjong, A., Indarti, F. R., Nuffida, N. E., Ardhyanto, A., & Novianto, D. (2022). Sustainability principle in Nusantara architecture: Case study of the Tongkonan House, the Betawi Stage House, the Gadang House, and Lamin House. *IOP Conference Series: Earth and Environmental Science*, *1007*, Article 012015. https://doi.org/10.1088/1755-1315/1007/1/012015

Nielsen, S. D. (2022). Architectural sustainability as a cultural practice. In A. E. Toft & M. Rönn (Eds.), *Northernness Proceedings Series 2022–1* (pp. 139–161). Nordic Academic Press of Architectural Research. https://research.chalmers.se/publication/534388/file/534388_Fulltext.pdf

Olukoya, O. A. P., & Atanda, J. O. (2020). Assessing the social sustainability indicators in vernacular architecture—application of a green building assessment approach. *Environments*, *7*(9), Article 67. https://doi.org/10.3390/environments7090067

Paramita, K. D., Atmodiwirjo, P., & Sinuraibhan, S. (2022). Learning from contextual material practices in architecture: Exploring nature-based materials in Indonesia and Thailand. *IOP Conference Series: Earth and Environmental Science*, *1098*(1), Article 012040. https://doi.org/10.1088/1755-1315/1098/1/012040

Pareti, S., Valdebenito, V., Rudolph, L., & Bustamante, C. (2022). Green energy and environmental sustainability on vernacular architecture. The case of Ayllus of Atacama Desert and stilt houses of Chiloe. *IOP Conference Series: Earth and Environmental Science*, *1094*, Article 012003. https://doi.org/10.1088/1755-1315/1094/1/012003

Park, J.-W. (2024). From physics to environmental policy: Exploring Boltzmann distribution for carbon trading permit allocation. *Nakhara: Journal of Environmental Design and Planning*, *23*(1), Article 405. https://doi.org/10.54028/NJ202423405

Peltason, R., & Ong-Yan, G. (2017). *Architect: The pritzker prize laureates in their own words*. Hachette UK.

Peters, T. (2015). Sustaining the local: An alternative approach to sustainable design. *Architectural Design, 85*(2), 136–141. https://doi.org/10.1002/ad.1889

Purwaningrum, D. A. (2019). Perplexing discourse of Indonesian architectural identity: An understanding of contemporary Nusantaran architecture. *International Journal of Architecture and Urban Studies, 4*(2), 5–17. https://www.researchgate.net/publication/338710499_PERPLEXING_DISCOURSE_OF_INDONESIAN_ARCHITECTURAL_IDENTITY_AN_UNDERSTANDING_OF_CONTEMPORARY_NUSANTARAN_ARCHITECTURE

Purwaningrum, D. A. (2021). *Indonesian architecture and being Indonesian: Contemporary context of Nusantaran architecture in architectural design and theory* [Doctoral dissertation, The University of Melbourne]. https://minerva-access.unimelb.edu.au/bitstream/handle/11343/277047/236a5c5d-e139-eb11-94cd-0050568d0279_PURWANINGRUM-DissertationFinal-29June2021.pdf

Rashid, M., & Ara, D. R. (2015). Modernity in tradition: Reflections on building design and technology in the Asian vernacular. *Frontiers of Architectural Research*, *4*(1), 46–55. https://doi.org/10.1016/j.foar.2014.11.001

Ray, S., Haque, M., Sakib, Md. N., Mita, A. F., Rahman, M. D. M., & Tanmoy, B. B. (2021). Use of ceramic wastes as aggregates in concrete production: A review. *Journal of Building Engineering*, *43*, Article 102567. https://doi.org/10.1016/j.jobe.2021.102567

Razman, R., Khaw, S. T., Md Noh, N. I. F., Ng, J. L., Abd Wahid, A. Z., & Yasin, M. N. (2023). Readiness of Malaysia’s construction industry in adopting green building rating tools. *IOP Conference Series: Earth and Environmental Science*, *1205*, Article 012031. https://doi.org/10.1088/1755-1315/1205/1/012031

Reid, J., & Rout, M. (2020). Developing sustainability indicators–the need for radical transparency. *Ecological Indicators*, *110*, Article 105941. https://doi.org/10.1016/j.ecolind.2019.105941

Riaubiene, E., Navickeinė, E., & Dijokienė, D. (2023). The profile of Lithuanian architects in relation to the professional generations active today. *Landscape Architecture and Art*, *22*(22), 69–80. https://doi.org/10.22616/j.landarchart.2023.22.07

Robati, M., Oldfield, P., Nezhad, A. A., Carmichael, D. G., & Kuru, A. (2021). Carbon value engineering: A framework for integrating embodied carbon and cost reduction strategies in building design. *Building and Environment*, *192*, Article 107620. https://doi.org/10.1016/j.buildenv.2021.107620

Roostaie, S., Kouhirostami, M., Sam, M., & Kibert, C. J. (2021). Resilience coverage of global sustainability assessment framework: A systematic review. *Journal of Green Building, 16*(2), 23–53. https://doi.org/10.3992/jgb.16.2.23

Saleh, A., Saleh, N., Ali, O., Hasan, R., Ahmed, O., Alias, A., & Yassin, K. (2024). Green building techniques: Under the umbrella of the climate framework agreement. *Babylonian Journal of Machine Learning*, *2024*, 1–14. https://doi.org/10.58496/BJML/2024/001

Salman, M. (2019). Sustainability and vernacular architecture: Rethinking what identity is. In *Urban and architectural heritage conservation within sustainability* (pp. 1–16). IntechOpen. https://doi.org/10.5772/intechopen.82025

Shan, M., & Hwang, B. (2018). Green building rating systems: Global reviews of practices and research efforts. *Sustainable Cities and Society*, *39*, 172–180. https://doi.org/10.1016/j.scs.2018.02.034

Shaw, I. (2008). Ethics and the practice of qualitative research. *Qualitative Social Work*, *7*(4), 400–414. https://doi.org/10.1177/1473325008097137

Sirror, H. (2024). Lessons learned from the past: Tracing sustainable strategies in the architecture of Al-Ula heritage village. *Sustainability*, *16*(13), Article 5463. https://doi.org/10.3390/su16135463

Stierand, M., & Dörfler, V. (2016). The role of intuition in the creative process of expert chefs. *The Journal of Creative Behavior*, *50*(3), 178–185. https://doi.org/10.1002/jocb.100

Styhre, A., & Brorström, S. (2023). Awards and prizes as control devices: The case of urban development project awards. *Organization*, *30*(5), 1094–1112. https://doi.org/10.1177/13505084211061245

Sujanová, P., Rychtáriková, M., Mayor, T. S., & Hyder, A. (2019). A healthy, energy-efficient and comfortable indoor environment: A review. *Energies, 12*(8), Article 1414. https://doi.org/10.3390/en12081414

Tienthavorn, T. (2024). Conserving Thailand's wooden built heritage: Developments, approaches, and current challenges. *Nakhara: Journal of Environmental Design and Planning*, *23*(1), Article 404. https://doi.org/10.54028/NJ202423404

Tuhkanen, H., Cinderby, S., Bruin, A. de, Wikman, A., Adelina, C., Archer, D., & Muhoza, C. (2022). Health and wellbeing in cities–cultural contributions from urban form in the Global South context. *Wellbeing, Space and Society*, *3*, Article 100071. https://doi.org/10.1016/j.wss.2021.100071

United Nations Environment Programme. (2022). *2022 global status report for buildings and construction*. https://wedocs.unep.org/items/c22095a1-fbcc-4378-8a42-b87ef3ec724

U.S. Green Building Council. (2025). *LEED v4.1: Building design and construction*. https://www.usgbc.org/leed/v41

Utami, L. A., Lechner, A. M., Permanasari, E., Purwandaru, P., & Ardianto, D. T. (2022). Participatory learning and co-design for sustainable rural living, supporting the revival of indigenous values and community resiliency in Sabrang village, Indonesia. *Land*, *11*(9), Article 1597. https://doi.org/10.3390/land11091597

Uzunkaya, A., & Paker Kahvecioğlu, N. (2022). Architectural design research through reflection: A sub-approach under "research by design." *Open House International*, *47*(4), 688–709. https://doi.org/10.1108/OHI-07-2021-0155

Varma, C. R. S., & Palaniappan, S. (2019). Comparision of green building rating schemes used in North America, Europe and Asia. *Habitat International*, *89*, Article 101989. https://doi.org/10.1016/j.habitatint.2019.05.008

Vyas, G. S., & Jha, K. N. (2016). Identification of green building attributes for the development of an assessment tool: A case study in India. *Civil Engineering and Environmental Systems, 33*(4), 313–334. https://doi.org/10.1080/10286608.2016.1247832

Wali, A., Alvira, D., Tallman, P. S., Ravikumar, A., & Macedo, M. O. (2017). A new approach to conservation: Using community empowerment for sustainable well-being. *Ecology and Society*, *22*(4), Article 6. https://doi.org/10.5751/ES-09598-220406

Wang, M. (2020). The role of local knowledge for rural revitalization in China: Social-ecological lessons learned through disasters, architecture, and education. In D. Fanfani, & A. Matarán Ruiz (Eds.), *Bioregional Planning and Design: Volume II: Issues and Practices for a Bioregional Regeneration* (pp. 259–278). Springer, Cham. https://doi.org/10.1007/978-3-030-46083-9_15

Walker, E., Jowett, T., Whaanga, H., & Wehi, P. M. (2024). Cultural stewardship in urban spaces: Reviving Indigenous knowledge for the restoration of nature. *People and Nature*, *6*(4), 1696–1712. https://doi.org/10.1002/pan3.10683

Wardhani, D. K., & Susan. (2019). Greenship assessment of indoor health comfort in adaptive reused buildings. In *Proceedings of the Annual International Conference on Architecture and Civil Engineering* (pp. 236–244). https://dspace.uc.ac.id/bitstream/handle/123456789/2584/Paper2584.pdf?sequence=4

Wasilah, W. (2023). Understanding local architectural forms as a sustainable design transformation. In A. Almusaed, A. Almssad, I. Yitmen, M. Wallhagen, & Y.-F. Yang (Eds.), *Integrative approaches in urban sustainability: Architectural design, technological innovations and social dynamics in global contexts*. IntechOpen. https://doi.org/10.5772/intechopen.109560

Widiarso, T. (2022). *The role of architects' rationality in the conceptual design creative process* [Doctoral dissertation, Institut Teknologi Bandung].

Widiarso, T., Hanan, H., & Tedjo, B. (2021). Rationality as the driver of the creative process in architectural design. *Advances in Social Science, Education and Humanities Research, 602*, 1–10. https://doi.org/10.2991/assehr.k.211126.001

Widodo, J. (2019). Human, nature, and architecture. *ARTEKS, Jurnal Teknik Arsitektur*, *4*(1), 127–130. https://doi.org/10.30822/arteks.v4i1

Wiles, R., Crow, G., Heath, S., & Charles, V. (2008). The management of confidentiality and anonymity in social research. *International Journal of Social Research Methodology*, *11*(5), 417–428. https://doi.org/10.1080/13645570701622231

Wirjawan, G. (2024). *The paradox of sustainability definitions* (Shorenstein Asia-Pacific Research Center working paper). Stanford University. https://aparc.fsi.stanford.edu/publication/paradox-sustainability

Wu, S. R., Fan, P., & Chen, J. (2016). Incorporating culture into sustainable development: A cultural sustainability index framework for green buildings. *Sustainable Development*, *24*(1), 64–76. https://doi.org/10.1002/sd.1608

Yakoub, W. A., Eleinen, O. M. A., Mahmoud, M. F., & Elrayies, G. M. (2021). Developing a holistic green urban meter: An analytical study of global assessment tools for urban sustainability. *International Journal of Sustainable Development and Planning*, *16*(2), 263–275. https://doi.org/10.18280/ijsdp.160206

Zainul Abidin, N., & Powmya, A. (2025). Identifying barriers in constructing green buildings in Oman: A study on project contractors' experience. *Built Environment Project and Asset Management*, *15*(1), 67–84. https://doi.org/10.1108/BEPAM-02-2024-0044

Zhukovskiy, Y. L., Batueva, D. E., Buldysko, A. D., Gil, B., & Starshaia, V. V. (2021). Fossil energy in the framework of sustainable development: Analysis of prospects and development of forecast scenarios. *Energies*, *14*(17), Article 5268. https://doi.org/10.3390/en14175268