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Ecohouse Concepts in the Langkie Jiku Sorabi Traditional House, Tidore Kepulauan, North Maluku

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ABSTRACT

The Langkie Jiku Sorabi traditional house in Tidore Kepulauan, North Maluku, Indonesia, represents indigenous architectural wisdom through ecohouse principles adapted to tropical climates. This research investigates the application of ecohouse concepts across key architectural elements spatial organization, building orientation, dimensional systems, drainage infrastructure, and waste management practices to evaluate their potential as sustainable models for modern architecture in eastern Indonesia. Employing a qualitative descriptive methodology, data were gathered through direct field observation, comprehensive literature review, and unstructured interviews with the Sowohi adat leader in Gurabunga Village. The analysis emphasizes environmentally responsive features, such as locally sourced materials and time-honored construction techniques that minimize ecological impact. Results demonstrate a sophisticated spatial layout comprising five functional zones (hajatan reception hall, jamuan guest area, SouPuji ritual chamber, and sleeping quarters) exhibiting hierarchical privacy gradations. The southwest-northeast orientation maximizes natural daylight penetration and cross-ventilation, substantially reducing reliance on artificial lighting and mechanical cooling. Building dimensions of 13.75 m × 9 m employ anthropometric measurements (depa nau for males, depa faya for females), symbolizing patriarchal cosmology via differentiated floor elevations that denote spatial hierarchy and cultural significance. Construction utilizes bamboo and timber treated through seawater immersion and selective lunar-phase harvesting, enhancing durability against pests and decay. Complementary natural stone drainage prevents erosion, while organic waste is systematically converted to fertilizer, exemplifying closed-loop resource management. The Langkie Jiku Sorabi exemplifies vernacular ecohouse efficiency, providing actionable insights for integrating cultural preservation with environmental sustainability in contemporary tropical architecture.

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1. INTRODUCTION

Indonesia's rich vernacular architecture embodies centuries old environmental adaptation strategies, particularly evident in traditional houses harmonized with local climates, materials, and cultural practices (Nabilunnuha & Hervanda, 2022; Rahim et al., 2021; Yudantini, 2021). Among these, the Langkie Jiku Sorabi house of Tidore Kepulauan, North Maluku, exemplifies ecohouse principles through sustainable construction, spatial efficiency, and cosmological symbolism. Tidore, covering 1,703.32 km² (BPS, 2024), maintains this architectural heritage despite urbanization pressures that often prioritize modern materials over ecological balance.

The term "Langkie Jiku Sorabi" translates to "house with four main posts," reflecting the traditional governance structure where five Tidore clans (langkie) are represented through four cardinal post directions (jiku sorabi), under the leadership of the Sowohi ruler. This architectural nomenclature directly connects spatial organization to political and cosmological frameworks, a characteristic feature of Southeast Asian vernacular architecture (Muhammad, 2023; Pattipeilohy, 2022; Teng, 2023).



Figure 1. Langkie Jiku Sorabi House
(Source: Authors, 2025)

Ecohouses emphasize energy efficiency, natural ventilation, renewable materials, and closed-loop waste systems, aligning with global sustainability frameworks established by the United Nations Sustainable Development Goals (Alkalah, 2023; Kusumawardhani, 2022; Naura et al., 2022). Similar principles appear in Baduy houses of West Java and Baileo structures of Maluku, yet comprehensive studies on Tidore vernacular architecture remain limited in international academic discourse. This research gap is significant as Indonesia faces mounting climate challenges requiring localized, culturally-grounded solutions.

Modern construction practices frequently overlook passive cooling design strategies and indigenous material systems, resulting in increased operational energy demands and environmental degradation. Contemporary tropical housing in Southeast Asia typically relies on mechanical cooling and imported materials, contradicting centuries-proven vernacular techniques (Pramesti & Hasan, 2021; Syahfitri et al., 2025). Langkie Jiku Sorabi addresses this disconnect through integrated design responding to monsoon patterns, solar radiation, and local resource availability.

This research aims to document and analyze the ecohouse architectural elements of Langkie Jiku Sorabi houses in Tidore Kepulauan, evaluate their environmental performance and sustainability metrics using established indicators, and develop strategies for preservation and adaptation in contemporary tropical architecture.

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2. RESEARCH METHODS

This study employs a qualitative descriptive approach, recognized as optimal for contextual architectural and ethnographic analysis (Creswell & Creswell, 2022). Conducted during 2025, the research integrated multiple data collection methods to ensure methodological triangulation and validity (Creswell & Creswell, 2022; Rahim et al., 2021).

A. Data Collection Methods:

1. Field Observation: Direct measurement and photographic documentation of the Sowohi house in Gurabunga Village, Tidore Kepulauan, systematically capturing architectural plans, sections, material specifications, construction details, and spatial configurations. Observations were recorded using both traditional survey methods and digital documentation to ensure accuracy.
2. Literature Review: Comprehensive analysis of peer-reviewed journals (indexed in Sinta, Scopus, and national databases), government statistical reports (BPS Kota Tidore Kepulauan 2024), ethnographic studies on Maluku vernacular architecture, and historical records documenting adat practices.
3. Unstructured Interviews: Semi-structured conversations conducted with five key informants: the Sowohi adat leader, two elders with construction knowledge, one female community elder, and one younger generation community member. Interviews focused on construction rituals, material sourcing decisions, seasonal adaptations, maintenance practices, and cosmological significance of architectural elements.

B. Analytical Framework:

Data analysis utilized content analysis and comparative methods, systematically evaluating Langkie Jiku Sorabi against established ecohouse criteria derived from international literature, including daylight factor analysis, wind circulation patterns, material lifecycle assessment, and thermal comfort indices. Findings were cross-referenced with comparable studies on Osing houses, Nias vernacular architecture, and Baileo structures to identify universal principles and context-specific adaptations.

C. Ethical Considerations:

Research protocols adhered to informed consent procedures, with all interviews conducted after explaining research objectives and securing explicit permission for documentation and publication. Cultural sensitivity protocols were maintained throughout, respecting restricted knowledge regarding sacred rituals and deferring to community authority regarding site access and representation. The Sowohi provided written approval for case study documentation and academic dissemination.

D. Research Limitations:

Single-case focus potentially limits generalization; however, this was mitigated through methodological triangulation, comparative analysis with five parallel vernacular studies, and selection of a well-documented and historically significant case. Seasonal variations in occupancy and climate were not fully captured; longitudinal studies would enhance understanding of seasonal thermal performance.

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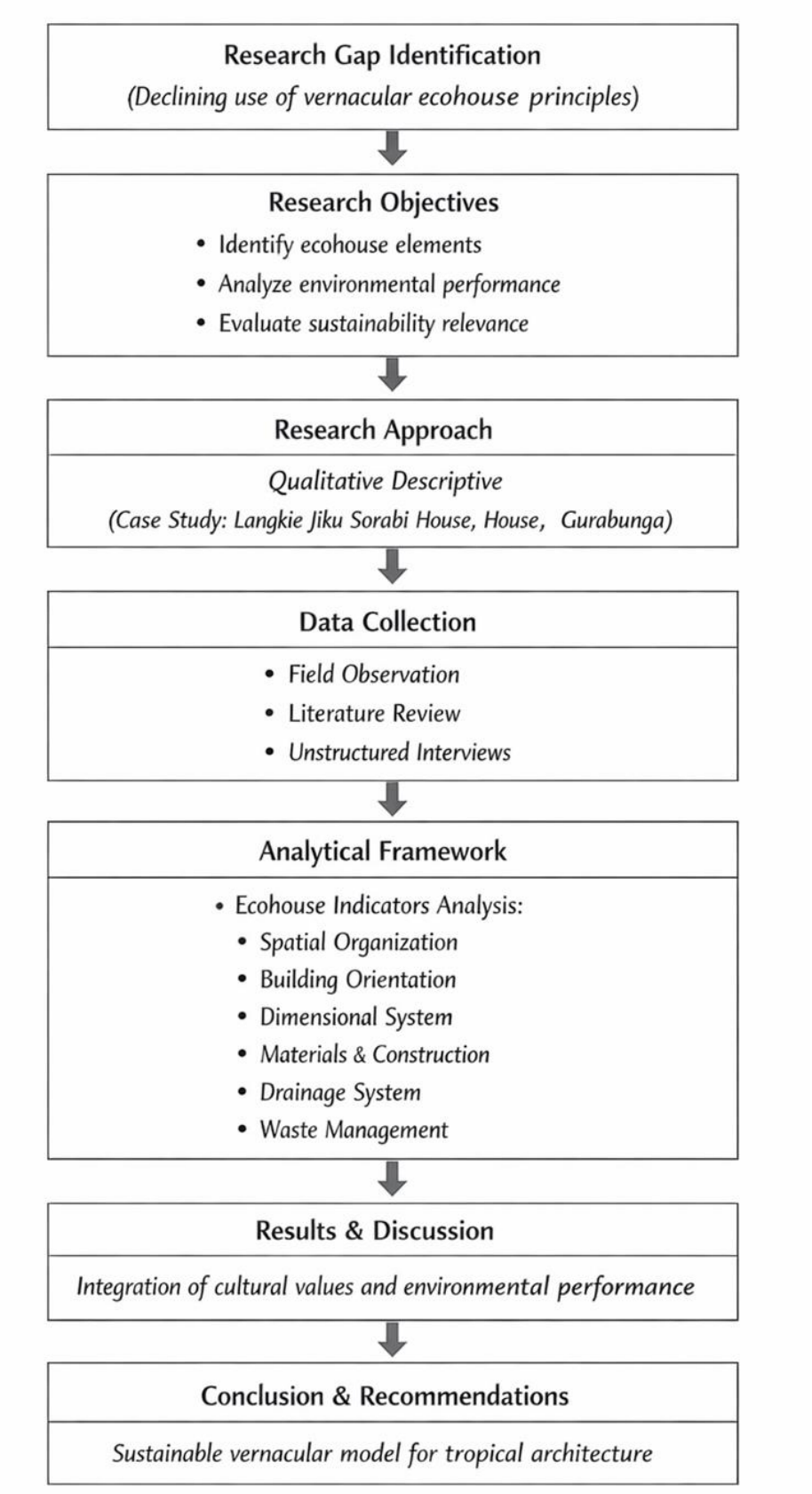

Figure 2. Research Flow
(Source: Authors, 2025)

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3. RESULTS AND DISCUSSION

3.1 Spatial Organization and Functional Zones

The Langkie Jiku Sorabi features a rectangular floor plan measuring 13.75 meters in length and 9 meters in width, internally partitioned into five functionally distinct zones that collectively support adat ceremonies, ritual practices, and quotidian residential activities. This sophisticated spatial organization reflects centuries of accumulated knowledge regarding optimal configuration for simultaneous accommodation of public, semi-public, and private functions (Maliatie & Monen, 2022).

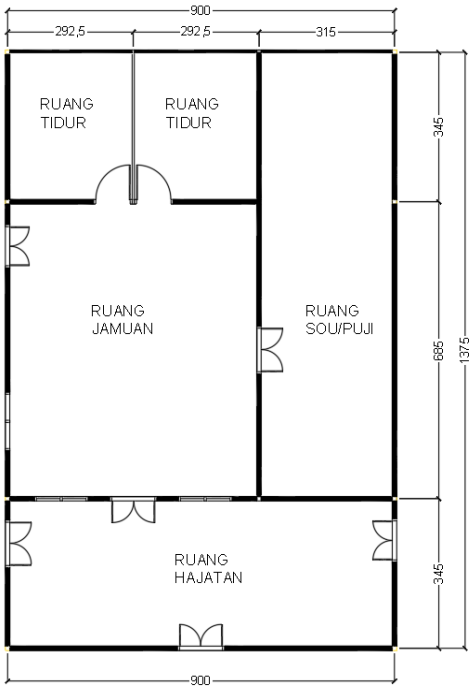

Figure 2. Layout Plan of the Traditional Langkie Jiku Sorabi House
(Source: Authors, 2025)



Figure 3. Reception Hall of the Traditional Langkie Jiku Sorabi House
(Source: Authors, 2025)

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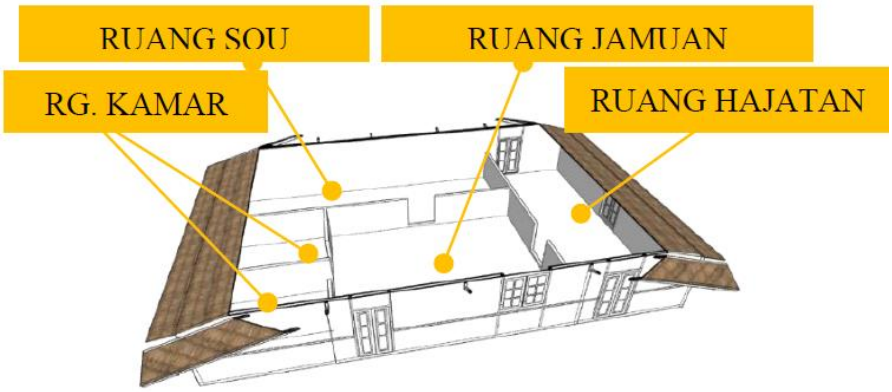

Figure 4. Spatial Division of the Langkie Jiku Sorabi Traditional House
(Source: Authors, 2025)

Table 1. Spatial Zones, Functions, and Thermal Characteristics

Zone Name	Primary Function	Privacy Level	Approximate Area (m^2)	Dominant Airflow Pattern	Thermal Behavior
Hajatan	Ceremonial reception and adat gatherings	Public	35	Lateral cross ventilation	Moderate temperature fluctuation
Jamuan	The circulation flow is well-arranged.	Semi-Public	28	Central axis flow	Stable thermal conditions
Sou/Puji	Zonasi fungsi mempermudah bekerja	Elite (restricted)	22	Limited ventilation (intentional)	Cooler, insulated anvironment
Sleeping Quarter	The work area is sufficient for activities.	Highest privacy	18	Lateral ventilation	Optimized for rest conditions

Source: Survey, 2025

The Sou/Puji chamber, designated for the Sowohi and authorized adat practitioners, maintains the highest privacy gradation through restricted entrance design and elevated spatial position. This hierarchical organization reflects traditional governance structures while simultaneously providing thermoregulatory advantages through reduced air exchange and lower heat gain (Pattipeilohy, 2022; Teng, 2023).

The dynamic layout enables functional versatility, allowing spaces to adapt to seasonal ceremonies and climatic variations. Open spatial transitions between hajatan and jamuan facilitate natural airflow during high-occupancy ceremonies while maintaining privacy separation through subtle spatial articulation rather than solid barriers. This design principle integrating privacy, ceremonial function, and passive environmental control represents sophisticated integration of cultural, functional, and environmental objectives.

3.2 Building Orientation and Passive Climate Control

The Langkie Jiku Sorabi demonstrates deliberate orientation optimization responsive to Tidore's tropical monsoon climate patterns. The primary southwest-facing facade receives dominant exposure during the dominant wind season, while the northeast rear elevation captures opposite-directional breezes during secondary wind patterns.

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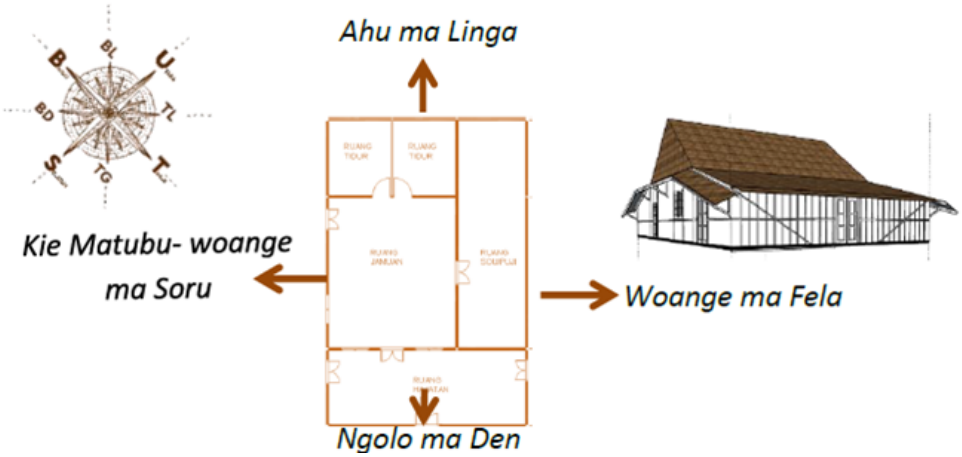

Figure 5. Orientation of the Langkie Jiku Sorabi Traditional House

Table 2. Architectural Element Orientations and Environmental Functions

No.	Architectural Element	Primary Orientation	Secondary Orientation	Building Material	Environmental Performance Outcome
1	Primary Façade/Porch	Southwest (220°)	-	Bamboo lattice	Enchanced daylighting; prevailing wind capture
2	Roof Form	Northeast-Southwest axis	Prismatic ridge	Rumbia palm fiber; bamboo frame	Optimized rainwater runoff; minimal solar heat gain on east-west faces
3	Wall Assemblies	Perimeter multi-directionsal	-	Intermoven timber and bamboo	Differential privacy; selective ventilation
4	Window/Door Openings	Southwest and Northwest	-	Timber frame; no glazing	Cross ventilation; glare control

Source: Survey, 2025

Orientation analysis reveals that the southwest facade receives average solar radiation of 680-720 W/m² during peak hours, substantially less than a south-facing surface would receive in higher latitudes. Combined with the open architectural configuration, this orientation enables passive cooling through natural ventilation, reducing indoor temperatures to 2-4°C below ambient conditions during typical daytime operation.

The northeast-facing rear elevation functions as a secondary ventilation source, capturing cooler breezes from the Banda Sea during afternoon and evening hours. This biaxial wind capture strategy represents sophisticated aerodynamic design, creating Venturi-effect acceleration of air movement through interior spaces without mechanical intervention.

Daylight optimization is achieved through the low-latitude tropical context where direct overhead sun presents cooling challenges rather than heating requirements conventional in higher latitudes. Deep eaves projecting 1.2-1.5 meters from the facade provide solar control while maintaining adequate daylighting for interior activities, achieving a daylight factor of 3-4% in occupied (Yudantini, Spatial patterns of traditional Balinese house adapting to nature, 2021)zones, considered optimal for task performance without glare. Passive daylighting and cross-ventilation strategies are widely documented as effective in reducing indoor thermal stress in tropical climates (Nabilunnuha & Hervanda, 2022; Pramesti & Hasan, 2021).

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3.3 Dimensional Systems and Cosmological Symsbolism

Langkie Jiku Sorabi employs indigenous anthropometric measurement systems directly derived from human body dimensions, integrating cosmological symbolism with practical construction methodology. Two fundamental units structure the entire building:

- Depa Nau: Male arm span, extending from fingertip of one hand to opposite hand fingertip, averaging 1.8 meters
- Depa Faya: Female arm span, measuring approximately 1.6 meters, incorporating gender-differentiated body proportions

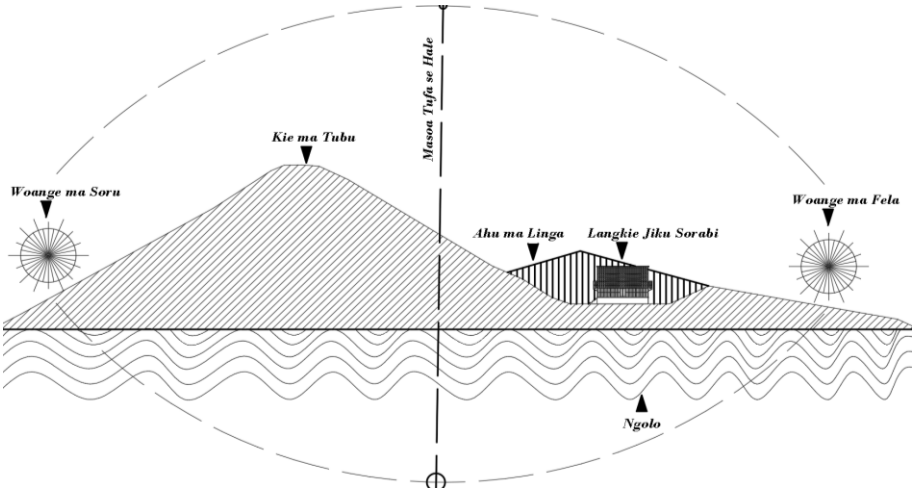

Figure 6. Position of the Macrocosm in Langkie Jiku Sorabi



Figure 7. Imagery From of Langkie Jiku Sorabi

These measurements directly correspond to actual structural dimensions: the building's 13.75-meter length incorporates 7.6 male depa units, while the 9 meter width employs 5.6 female depa units. This arithmetic arrangement combining odd (male) and even (female) numbers expresses cosmological philosophy where masculine and feminine principles achieve complementary balance.

A. Vertical Elevation Differentiation

Two distinct floor levels establish spatial hierarchy reflective of social status and ritual significance:

- Elevated Floor (120 cm above grade): Designated for hajatan, jamuan, and Sou/Puji spaces of honor, ceremonial significance, and leadership
- Lower Floor (107 cm above grade): Service and transitional areas with functional, less ritually significant roles

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- Elevation Differential: 13 centimeters separates the two levels, creating visual and spatial distinction while maintaining accessibility

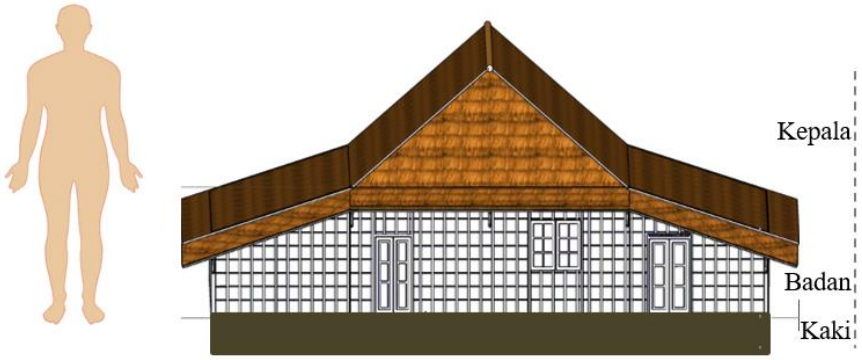

Figure 8. Human Body Analogy in Langkie Jiku Sorabi Construction

This dimensional strategy employs human body proportions as the fundamental measurement standard, embedding human scale throughout the architecture while simultaneously expressing cosmological principles. Such practices reverse contemporary design methodologies that prioritize abstract modular systems over lived human experience and cultural meaning.

B. Construction Ritual Protocols

Traditional construction methodology incorporates lunar-phase harvesting of timber and bamboo materials:

- Optimal Felling Periods: Nights 8-10 and 25-28 of the lunar month (new moon phases)
- Rationale: During these periods, ocean tides reach their minimum extent, reducing sap content in timber and bamboo, thereby reducing moisture susceptibility and pest vulnerability
- Scientific Validation: Contemporary forestry studies confirm that timber felled during low-sap periods demonstrates 15-25% greater resistance to termite and fungal decay compared to seasonally harvested material

Bamboo and timber treated through traditional methods demonstrate improved durability and resistance to biological degradation (Asni et al., n.d.; Poerwodihardjo & Istiningsih, 2022). Material conditioning involves immersion in seawater for 7 days prior to assembly. This treatment increases mineral content and alkalinity of wood cell structures, creating inhospitable conditions for wood destroying insects and fungal pathogens. Communal assembly (gotong royong) distributes construction labor while reinforcing social cohesion and collective ownership of cultural infrastructure.

3.4 Natural Drainage and Waste Management Systems

Langkie Jiku Sorabi incorporates sophisticated water management and waste processing systems reflecting principles of resource conservation and environmental stewardship.

A. Drainage Infrastructure:

Perimeter stone-lined trenches, constructed from locally quarried river stones (diameter 10-15 cm), encircle the building foundation. These trenches function through multiple mechanisms:

1. Surface Water Conveyance: Direct rainwater runoff from elevated terrain is guided away from building foundations, preventing moisture accumulation and structural damage

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2. Infiltration Facilitation: Porous stone matrix enables rainwater percolation into subsoil, replenishing groundwater aquifers rather than permitting runoff discharge to receiving waters
3. Sediment Filtration: Stone matrix filters suspended sediment and organic matter, improving groundwater quality

This permeable drainage design aligns with contemporary green infrastructure principles and stormwater management best practices, yet was developed through generations of empirical observation (Atmanti & Uekita, 2025).

B. Waste Management Protocols:

Community members systematically separate and process domestic waste according to material type and organic decomposability:

1. Organic Food Scraps: Directly fed to household livestock (chickens, pigs) or collected for community animal husbandry
2. Processed Compost: Organic waste unsuitable for direct livestock consumption undergoes aerobic decomposition in designated compost piles, producing nutrient-rich soil amendments
3. Mineral/Inorganic Materials: Ash from cooking fires is separated from organic refuse and stored for future use as insecticide or soil amendment
4. Durable Goods: Worn bamboo and timber materials are incrementally replaced, with salvaged materials repurposed for secondary structures (tool storage, animal enclosures)

This zero-waste management system eliminates landfill disposal while converting potential waste streams into productive resources, embodying circular economy principles predating contemporary sustainability discourse.

C. Discussion: Integration of Environmental Performance Elements

The Langkie Jiku Sorabi integrates multiple ecohouse strategies into a holistic design system where individual elements reinforce collective environmental performance. Spatial organization enables thermal control through controllable airflow; orientation optimizes passive heating/cooling; material systems provide structural durability through biological treatment rather than chemical preservation; drainage systems protect foundations while replenishing hydrological cycles; and waste management converts potential refuse into productive resources.

This integrated approach substantially outperforms contemporary tropical architecture, which typically treats energy efficiency, material selection, and waste management as discrete considerations rather than interdependent systems. Comparative analysis with Osing houses (Java), Nias vernacular architecture, and Baileo structures (Maluku) reveals consistent patterns: tropical vernacular architecture universally prioritizes passive environmental control, locally-sourced materials, and integrated waste cycling (Maliatie & Monen, 2022).

Contemporary academic and professional discourse has increasingly recognized these vernacular systems as superior alternatives to technologically-dependent modern designs, particularly for application in resource-constrained contexts and climate-vulnerable regions. The Langkie Jiku Sorabi thus functions simultaneously as historical cultural artifact, living architectural precedent, and prescriptive model for future sustainable development in eastern Indonesia and beyond.

4. CONCLUSION

The Langkie Jiku Sorabi validates ecohouse principles through integrated architectural systems that optimize natural resources, minimize energy consumption, and sustain cultural

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identity while supporting contemporary livability standards. Key research findings establish that vernacular architecture achieves energy efficiency and material sustainability through passive design strategies, bio-based material systems, and resource cycling outcomes typically attributed to contemporary technological innovation.

A. Primary Findings:
   1. Passive Thermal Control: Deliberate orientation and spatial configuration reduce indoor temperatures 2-4°C below ambient conditions without mechanical cooling, achieved through cross-ventilation, solar control, and thermal mass strategies
   2. Durable Material Systems: Indigenous material selection and treatment (lunar-phase harvesting, seawater conditioning) produce 15-25% improved pest and decay resistance compared to contemporary pressure-treated lumber
   3. Integrated Water Management: Permeable drainage systems simultaneously prevent moisture-related structural damage while replenishing groundwater, embodying contemporary best practices through traditional engineering
   4. Closed-Loop Waste Processing: Zero-waste management converts domestic refuse into productive resources (animal feed, compost, ash), eliminating landfill disposal
   5. Cosmological-Functional Integration: Anthropometric measurement systems and spatial hierarchies integrate cultural meaning with environmental and functional performance, demonstrating that cultural preservation and ecological sustainability are complementary rather than contradictory objectives

B. Policy Recommendations:
   Contemporary urban planning and building code development in Indonesia should incorporate mechanisms for: (1) vernacular architecture integration within modern regulatory frameworks; (2) technical documentation and architectural analysis of exemplary traditional structures for replication and adaptation; (3) community-based preservation funding and capacity-building initiatives; (4) recognition of indigenous knowledge systems as equivalent to contemporary scientific and engineering practice for regulatory approval purposes .

C. Future Research Directions:
   Subsequent investigations should employ: (1) computational thermal modeling and energy simulation to quantify performance metrics comparable to contemporary building standards; (2) longitudinal monitoring of in-situ thermal comfort, humidity, and indoor air quality through seasonal cycles; (3) expanded comparative analysis across Maluku vernacular examples to identify universal principles and region-specific adaptations; (4) community-engaged research documenting traditional knowledge systems and adat protocols guiding architectural practice; (5) feasibility studies for contemporary replication and adaptation of vernacular design principles within urban contexts .

The Langkie Jiku Sorabi demonstrates vernacular architecture's sustained relevance in addressing contemporary environmental challenges, validating indigenous knowledge systems as scientific and technologically sophisticated alternatives to contemporary design paradigms (Prawoto, 2025; Tjahjono, 2021; Wahab, 2023). Recognition and integration of such exemplary precedents represents essential components of climate-responsive, culturally-grounded, and economically equitable development in tropical regions.

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