





Spatial Analysis of Indonesian Vernacular Houses in Three Regions Towards Sustainable Architecture Development

Balqis Setyatita Ramadhani¹, Gabriela Emily Xian¹, Rusyda Tamma Hidayat², Achmad Nailu Rosyad¹, Irvansyah¹, and Didit Novianto¹*

¹ 1 Department of Architecture, Institute Technology of Sepuluh Nopember, Kampus ITS Keputih, Sukolilo, Surabayaa 60111, Indonesia

² 2 Department of Architecture, University of Kitakyushu, 1-1 Hibikino, Wakamatsu Ward, Kitakyushu, Fukuoka 808-0135, Japan

*didit.novianto@its.ac.id

Abstract. This study root into the adaptation of vernacular Indonesian architecture within the modern context. It focuses on the evolution of vernacular houses, specifically Joglo houses in Central Java, Taneyan Lanjhang in East Java, and Kampung Naga in West Java. The selected regions represent a wide spectrum of Indonesian societal structures, providing a comprehensive view of communal and private living spaces. The aim of this paper is to reinterpret these vernacular forms into modern architectural designs while preserving their essential qualities. Utilizing space syntax methodology, the research assesses the impact of these structures on social interaction and cultural expression. The analysis reveals varying spatial interaction patterns: high integration in communal areas of Taneyan Lanjhang in Bangkalan and Joglo in Pati, contrasted with a distinct separation of public and private spaces in Kampung Naga Village. Through observation and analysis, the study explores the interplay between spatial arrangement and social dynamics, underscoring the importance of incorporating vernacular spatial concepts into contemporary design. The highlights are how these traditional structures balance communal living and individual privacy, aligning with principles ecological, social, and cultural sustainability. This study metaphorically extracts the architectural 'DNA' of vernacular houses also underscore the importance of preserving traditional architectural elements while adapting them to contemporary contexts, thus maintaining their essence and cultural heritage. This study can be used for guiding architects in blending cultural heritage with modern design, such as development at IKN. It can helps governments and stakeholders develop sustainable housing by preserving tradition while modernizing functionality.

Keywords: indonesian vernacular house; joglo; kampung naga; space syntax; taneyan lanjhang

1 Introduction

At the dawn of the 21st century, a significant shift has occurred within capitalist societies, where creativity has begun to overshadow mere functionality and efficiency. This evolution profoundly affects the daily lives of people, who now prioritize more than just convenience in their living spaces [1].

© The Author(s) 2024

M. Musyarofah et al. (eds.), *Proceedings of the 5th Borneo International Conference (BICAME 2024): Symposium on Digital Innovation, Sustainable Design and Planning (DSP)*, Advances in Social Science, Education and Humanities Research 882,

https://doi.org/10.2991/978-2-38476-329-0_14

The most pressing issue in Java is the rapidly growing population, which causes a decline in agricultural land and prompts large-scale development. One notable concern is the construction of houses inspired by Indisch architecture, a blend of medieval Dutch and local styles. This trend, driven by a humanistic mindset emphasizing rational solutions and freedom of thought, has led to the rise of modernism [2]. Consequently, traditional cultural heritage in the archipelago is eroding, losing its local identity. The rapid social changes are marginalizing traditional architectural symbols, leading to a loss of cultural values[2].

A specific issue arises in the development of traditional houses, which seems to have reached a plateau. In Indonesian traditional architecture, particularly in religious buildings and residences, there exists a unique character. This uniqueness is both static and dynamic, the latter evident in efforts to preserve by reusing past architectural elements in contemporary contexts. This approach involves critically interpreting these elements, as articulated in Ricoeur's philosophy of modernity reconciled with tradition and the principle of critical regionalism. Preservation is no longer about mere conservation but about contextualizing past architecture in present times, encompassing its spirit and ideas rather than just its physical form. This approach remains relevant and consistent from the Colonial to the Post-Colonial era, as argued by Prajudi ini 2015, who sees it as a process of rethinking and redefining historical elements for contemporary use. We need to using the tangible and intangible aspects of Nusantara's distinctive architecture as a foundation to expand architectural knowledge, harmonizing it with Western classical architecture [3].

Research by Sahar in 2022, underscores the necessity of comprehensively studying spatial design factors. The findings offer urban designers and planners valuable insights into the social sustainability of densifying urban areas, enhancing their decision-making processes. Investigating traditional houses in Indonesia is particularly pertinent due to the rich diversity of local wisdom, which is at risk of being lost in the absence of efforts to preserve the moral values of ancestors [4]. Traditional houses, or Rumah Adat, are not just unique dwellings of various ethnic groups but are also high representations of culture within communities. They are key to understanding the historical, heritage, and progressive aspects of a society. Supporting and enhancing traditional building methods could be the most practical and sustainable way to meet future housing needs[5].

The island of Java is home to numerous ethnic groups, each contributing to its rich cultural diversity. This study explores the cultures of West, Central, and East Java as representative of the region's lifestyle and societal practices, with a focus on architecture. It examines how traditional architectural styles reflect the distinct cultural values and ways of life in these areas, providing a deeper understanding of the connection between the built environment and local traditions.

This research aims to investigate the traditional Joglo house of Juwana, Central Java, Taneyan Lanjhang in East Java, and Kampung Naga in West Java. The goal is to uncover the meanings embedded in these architectures and translate them into new architectural forms, retaining their essence but with a fresh interpretation. This study will employ Space Syntax, a methodology for analyzing spatial configurations, to understand how these traditional structures facilitate social interaction and cultural expression. By comparing and finding common threads in these architectures, the research

seeks to identify the core elements that define traditional architecture's heart and soul, so that the architecture modernization in the next design would be align with indonesia's local genius. This study metaphorically extracts the architectural 'DNA' or heart and soul of vernacular houses, focusing on spatial patterns, materials, and cultural symbolism preserved across generations

This research can serve as a pioneer and guide for architects, particularly in the design of new cities like IKN, where the integration of sustainable practices is crucial. The development of IKN as a Smart City and Green City is focused on achieving net zero emissions (NZE) through the use of renewable energy sources [6]. Its architectural approach, rooted in the Neo-Nusantara concept, combines cutting-edge digital technologies with traditional vernacular elements, ensuring that the city's buildings are both culturally significant and technologically advanced through innovations like 3D printing [7].

2 Introduction

Several culture in Java Island have a variation notion of Macrocosm and Microcosm. In Javanese culture it is known as Jaghad Gedhe (Macrocosm) which refers to a sphere beyond human such as nature or god/deity and Jaghad Chilik (Microcosm) which usually refers to sphere of human society [8]. Understandin this concept was crucial to understanding the driving force behind Indonesian Vernacular Architecture as Indonesian Vernacular Houses is an reflection of its local people and culture attitudes toward the universe (Macrocosm) and the humankind (Microcosm). Many tradition understand that a person have relationship with their world and their peers, and should achieve for a balance and harmony with both aspect [9]. A Indonesian traditional architecture element form are perhaps caused by natural aspect of its context or a manifestation of its inhabitants beliefs or a culture symbol of reverence towards their surrounding [10], [11]. Interpersonal relationship and social aspect also play a huge role in shaping Indonesian Traditional Architecture, the spatial structure of a house for example could be a reflection on social structure of its society, a gender role and expectation of a person, or the relationship between its inhabitant with other inhabitant [12], [13], [14].

The three pillars of sustainable development—ecological, social, and economic—are interconnected and essential for achieving sustainability. However according to Jon, in 2001. Cultural vitality is as essential to societal health as social equity, environmental responsibility, and economic viability. For public planning to be effective, it must include cultural evaluation alongside social, environmental, and economic assessments. And that's become the fourth pillar of susustainability.

Cultural activities enhance community engagement, fostering belonging and social cohesion. Embracing cultural diversity and inclusion promotes social equity and justice, helping various groups coexist peacefully. Cultural values guide environmental interactions, with traditional ecological knowledge supporting sustainable resource management. Embedding sustainable practices in cultural norms ensures ecological sustainability as a collective priority. Thus, cultural sustainability is foundational, enhancing both social and ecological sustainability.

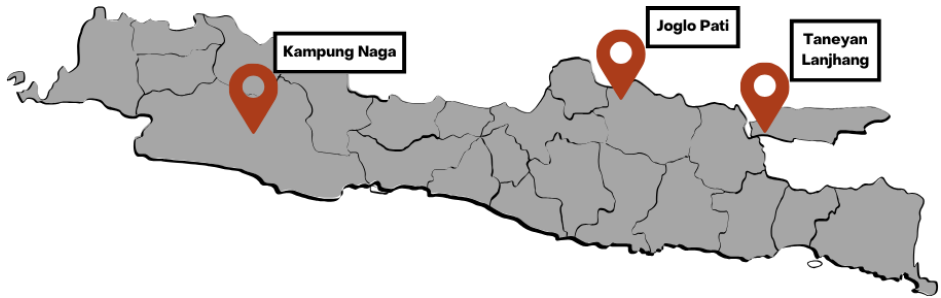


Fig.1. Location of Kampung Naga, Joglo Juwana, and Taneyan Lanjhang (source:google)

Kampung Naga houses emphasize ecological sustainability by using natural, locally-sourced materials, promoting natural ventilation, and avoiding electricity to prevent fire hazards, thus living in harmony with nature[15]. Socially, these houses foster communal living and cultural preservation, while economically supporting local livelihoods through agriculture and crafts. Joglo houses focus on cultural sustainability, fostering tradition and community with collective building practices and intergenerational living, using local teak wood and ensuring resource sustainability through replanting [16]. Economically, they symbolize social status and serve as long-term investments. Rumah tradisional Taneyan Lanjang integrates sustainability by using local materials and maximizing natural light and ventilation to reduce environmental impact. Social interactions and land use for agriculture and livestock strengthen community bonds, and the design ensures thermal comfort and natural air circulation, creating a sustainable living environment[17].

In terms of cultural influence, the local Javanese community continues to preserve certain building elements from the colonial era. In Ndalem Ngabean's Limasan, it is shown that colonial architecture affects some features of the structure. The wall structure that originally consists of wood or bamboo and it changed to the use of double-stacked brick in the wall structure as it was built around the colonialism era [5].

Previous studies on Javanese vernacular architecture primarily focus on the physical aspects of traditional houses, while research on how these designs are adapted in modern urban contexts remains limited. This gap is crucial, as understanding these adaptations can provide insights into the preservation of cultural heritage amid modernization. This study aims to bridge that gap by analyzing contemporary housing in Java that incorporates traditional architectural elements, thus contributing to academic knowledge and offering practical applications for sustainable design.**Sample Heading (Third Level)**. Only two levels of headings should be numbered. Lower level headings remain unnumbered; they are formatted as run-in headings.

3 Method

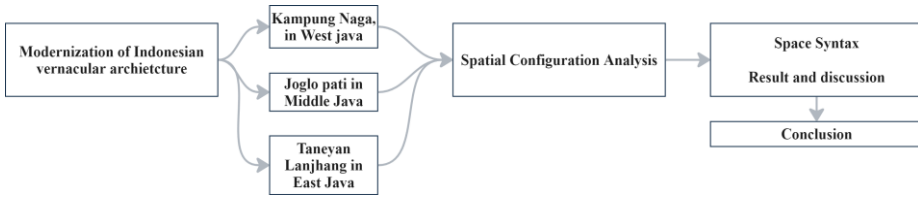


Fig.1. research framework diagram

This research employs a various kind of methodology to analyze traditional Indonesian houses in three distinct regions of Java: Alang Alang Village in Bangkalan, East Java for Taneyan Lanjhang houses; Juwana, Central Java for Joglo houses; and Kampung Naga in Tasikmalaya, West Java. In each region, over 50 houses were observed, with a minimum of 10 houses studied closely in each area. From this observational data, one prototypical house in each region was selected for detailed analysis based on its representativeness and prevalence.

Data collection involved direct observation across the three regions: Joglo Pati, Taneyan Lanjhang, and Kampung Naga. In Joglo Pati and Taneyan Lanjhang, more comprehensive methods were used, including interviews, measurements with tools like tape and laser meters, drone mapping, and detailed sketches. In Kampung Naga, due to limited contact with the Baduy community, data was gathered through village officials, supplemented by photos, measurements, and sketches.

The study utilizes Space Syntax, a theoretical framework developed by Hillier and Hanson (1984), which provides a systematic and mathematical approach to organizing spatial systems. Unlike shape grammar, Space Syntax encompasses both fundamental theory and advanced methods, allowing for the analysis of spatial configurations at various scales using the DepthMap software designed by Turner (2001) [18]. DepthMap facilitates comprehensive analysis across different Space Syntax maps and measurements, including convex spaces[19], Justified Plan Graph (JPG), Axial Line, isovist, Visibility Graph Analysis (VGA), and intersection points. These techniques transform maps into graph diagrams, processed mathematically to interpret social features in spaces.

Key quantitative parameters employed include Relative Asymmetry (RA), Integration, Control Value, and Space-Link Ratio R. These parameters, can be seen in table 1, assess spatial depth, integration, access control, and relational flexibility between spaces. Additionally, qualitative parameters like isovist analysis are used to evaluate visibility and spatial configurations [18].

Table 1 The explanation of parameter used in the research

Indicator	Explanation
Relative Asymmetry (RA)	A measure of how deep or isolated a space is compared to an ideal symmetrical system. RA helps to understand the hierarchical depth within the spatial system.

Integration Value	A global measurement that indicates the average depth of a space relative to all other spaces in the system. Higher integration suggests that the space is more central and accessible.
Control Value	This metric measures how much control a particular space exerts over the system, based on the number of connections it has. A high control value indicates a space that regulates access to other spaces.
R2 Value	A statistical measure that indicates the fit of the model used in space syntax analysis, often utilized to assess the accuracy of spatial predictions.
Isovist	Describes the visual field from a specific point within a space. It is often represented as a polygon showing all visible areas from that location. Isovist helps understand human visual perception within space.
Connectivity Value	This measures how many other spaces are directly connected to a specific space. Higher connectivity suggests more direct access, affecting movement patterns and usage of the space.
Visibility Graph Analysis (VGA)	A type of analysis that evaluates the visibility of spaces throughout a system, providing insights into how individuals might perceive and navigate the environment based on what they can see.
Justified Plan Graph (JPG)	A hierarchical graph that shows the accessibility and depth of spaces from a 'root' space, visualizing the levels of connectivity and the complexity of movement throughout the spatial system.

Comparative analysis is conducted to identify the essence of each region's architecture, noting similarities and differences. This approach aims to inform the modernization of traditional architecture and the development of Nusantara architecture, bridging historical wisdom with contemporary architectural practices.

Three case studies which each represent different culture and society are chosen to illustrate and give a broader understanding towards the interrelationship of a house to every aspect of its context. Each house which represents the three cases are also have different socio-economic conditions which will show how modernity affects the case study and how the case study fared in modern conditions.

Kampung Naga spans one and a half hectares, largely dedicated to housing, gardens, and ponds, with the remainder used for rice farming, which yields two harvests annually [20]. The inhabitants of Kampung Naga view nature as a sacred trust from their ancestors, vital for ensuring a high quality of life and seen as a divine creation to be preserved. These natural elements are essential for providing clothing, food, and shelter for the community [21].


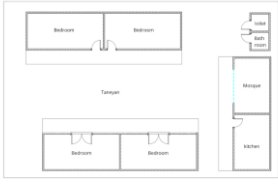
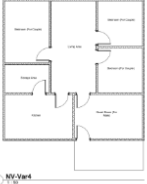
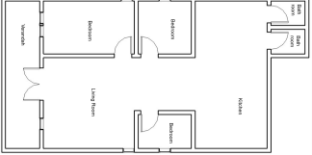
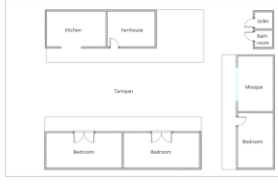
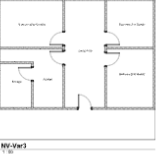

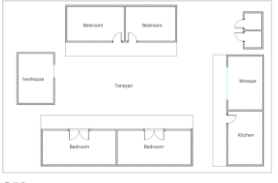
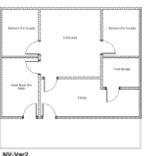
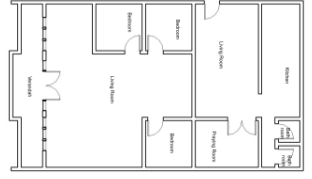
Santosa in 2000, explores the Javanese house as more than just a residence; it is a central venue for rituals and a symbolic stage. Prijotomo (1988, 1995, & 2006) reveals the deep lifestyle values in joglo architecture, emphasizing the intimate connection between the homeowner's soul and their house, often built proportionately to the owner's body. Prijotomo also examines Javanese architecture through specific scripts, highlighting the oral traditions of the Javanese people [22], [23].

Interviews with research samples show that the traditional community of Taneyan Lanjhang remains committed to preserving cultural values amidst modern society. Based on oral traditions, including purely oral, mixed oral and non-oral elements, and material oral traditions divided into material and non-material, the community believes in continuing the legacies of their ancestors [24]. The term Taneyan Lanjhang, derived

from "taneyan" (yard) and "lanjhang" (long), symbolizes a long yard, reflecting their cultural heritage [25].

Table 2 shows the typical floor plans of various traditional houses. Next, bubble diagrams are created to serve as a reference for determining the typical spatial configuration, which will then be analyzed using the space syntax method.

Table 2 observation and typical floorplan

Taneyan Lanjhang (TL)	House in Kampung Naga (KN)	Joglo Pati (JP)
		
Observed Floorplan		
TL 1	KN 1	JP 1
		
TL 2	KN 2	JP 2
		
TL 3	KN 3	JP 3
		
TL 4	KN 4	JP 4



LR: Living room, FD: Family dining, BR: Bedroom, MS: Praying area, KC: kitchen, TB: Toilet & Bathroom

To obtain representative data, after observing samples from several houses in each region, Table 3 explains the results of the typical spatial organization.

Table 3 each vernacular houses's typical spatial configuration

JP	TL	KN
<p>In Pati and Juwana, the average house layout adopts the original spatial division of the Joglo, featuring distinct areas: Sentong Kiwa and Tengen for bedrooms or</p>	<p>In Alang-Alang village, Bangkalan, a consistent U-shaped Taneyan Lanjang layout was observed, featuring a central</p>	<p>The architectural layout of houses in Kampung Naga features a modular design, encompassing three primary areas: a living room and kitchen</p>

workspaces, an open *Pendapa* for gatherings, transitional space (fusion of the *pendapa*, *pinggitan*, and *dalem ageng* without clear boundaries), and the innermost private family area, *Dalem*. [26]

'Taneyan' instead of separate living or family rooms [24]. Commonly, these houses include a *roma* (combined living and bedroom), *kobhung* (praying room), *dapoor* (kitchen), and variable service rooms, with occasional minor variations.

at the front, and a bedroom situated at the rear[20].



4 Result

4.1 Visibility Graph Analysis

Table 4 Examination of the selected sample utilizing Visibility Graph and Isovist methods.

	Space legibility	Isovist (from entrance)	Visibility Diagram
Joglo Pati			 R ² : 0.022
Kampung Naga			 R ² : 0.153
Taneyan Lanjhang			 R ² : 0.01

Taneyan Lanjhang in Bangkalan

According to the analysis of the spatial configuration of the taneyan or traditional courtyard in residential architecture, the balance between local and global spatial dynamics is very complex. The low R² value shows that local spatial configuration is quite fragmented, with minimal connectivity within two-step vicinities that might very well

carry a sense of isolation in immediate surroundings. However, this local isolation contrasts with a high average connectivity in the broader spatial network. This suggests an overarching interconnectedness that facilitates movement and visibility across the larger area, revealing a unique blend of seclusion and accessibility in traditional residential layouts.

Moreover, the medium strength visual value connection reflects the balance in direct line-of-sight connections between different points in the space. Analysis of isovist, specifically in the taneyan or courtyard area, shows that there is good visibility. This suggests that the room is public as opposed to, for instance, the *roma* (living room), *kob-hung* (prayer room), and *dapoer/dapur* (kitchen), which have a high level of partitions and thus exhibit some element of privacy. The mode of spatial placement adopted hence affects not only movement patterns but also becomes a confirmation of tendencies held in cultural residential architecture that classifies what is public and private.

Joglo in Pati

The spatial layout of the Joglo house in Juwana, Pati, is characterized by an open-plan arrangement, especially in the *pendapa* (main hall), transitional space, and dalem (inner space) that are arranged in a straight line. The *pendapa* is usually supported by four main joglo pillars (*saka guru*) and sometimes contains furniture with partitions that divide the dalem from the transitional space. Private spaces such as the mushalla and bedrooms are seen to enjoy equally higher degrees of privacy. The *pendapa*, being a living room, and the transitional space, being more specifically a family room, appear to be the primary nodes with the provision of other rooms. The isovist analysis from the entrance covers the whole of the *pendapa* and transitional space, plus part of the kitchen.

The spatial arrangement concurs with the R^2 value of 0.0226, indicating that the place is well distributed with moderate local connectivity, balancing privacy. It has high mean connectivity (1457.56) and high visual connection value (23.5506); it also shows a more connected, broader network with higher visibility and hence design to interact. This would depict a good spatial pattern arrangement in the Joglo house, balancing both private and public spaces—a characteristic feature of traditional Javanese architecture.

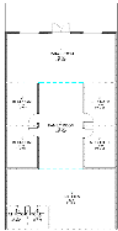
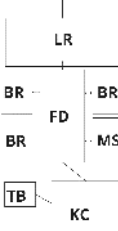
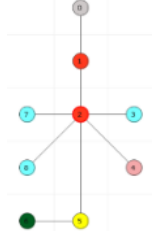
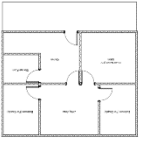
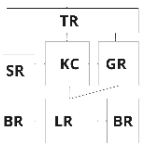
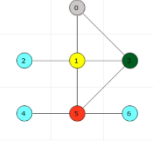
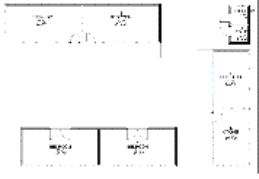

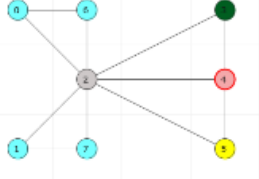
Kampung Naga Village

The architectural design of the traditional house in Kampung Naga, Selawu, Tasikmalaya, is constructed with distinctive architectural elements. In the other styles of the traditional house, the kitchen, situated at the front, is the first accessed area, not terrace, like in this case. This conception makes the kitchen and the attached living area, articulated to it through a partition, be at the same hierarchical level. Further inside the home, the guest room becomes more private because it is located inside the front yard. The most private spaces for this family and the couple are the storage and bedrooms. The living room is pretty central to the plan layout of the house, joined directly to four other rooms. It is a hub space linking different functions. On visibility, the isovist analysis from the entrance shows mostly the kitchen and part of the storage area when the

door is opened. Such spatial configuration, with an R^2 value at 0.153 and average connectivity amounting to 303.965, reflects good per-neighborhood connectivity while maintaining the entire spatial connectivity. However, a lower visual connection value of 3.24822 shows the visibility between other points being less, so it reflects the architecture of Kampung Naga as if the architecture is being done to establish privacy and seclusion in the communal setting.

4.2 Justified Plan Graph Analysis

Table 5 Introduction of the studied sample, convex map, and justified plan graph.

	Typical Spatial Plan	Convex Map	Justified Plan Graph
Joglo Pati			
Kampung Naga			
Taneyan Lanjhang			

LR: Living room, FD: Family dining, BR: Bedroom, MS: Praying area, KC: kitchen, TB: Toilet & Bathroom

Joglo in Pati

In Juwana's traditional Joglo house, a spatial analysis using Agraph Software gives us insight into the flow and layout of the house. The verandah, for example, has a Relative Asymmetry (RA) of 0.50, meaning it's placed somewhere in the middle of the house's hierarchy—not too isolated, but not entirely central either. This moderate positioning reflects its role as an entryway or a semi-public space. The integration value of 2.00 shows it's fairly accessible but not a major gathering spot. Its control value of 0.50 indicates it doesn't play a significant role in regulating movement between other rooms.

The living room, with a lower RA of 0.25, is more central, making it a hub for activity. Its integration value of 4.00 reflects this, showing that it's more accessible and

plays a key role in connecting the rest of the house. Additionally, its control value of 1.16 suggests it guides much of the movement within the house, serving as a primary access point to other spaces.

The family and dining room is even more central with an RA of 0.07, placing it as one of the core spaces. Its high integration value of 14.00 emphasizes its role as a key area for social interactions. The control value of 5.00 shows that this room significantly influences how people move through the house, underlining its importance.

Private spaces like the bedrooms and Musholla, with an RA of 0.32, have a moderate level of privacy. The integration value of 3.11 indicates these areas are accessible but not as prominent as communal spaces. Their control value of 0.16 suggests they don't heavily influence movement, which makes sense as they are meant to be secluded and peaceful. The kitchen mirrors the values of the living room, balancing its role between accessibility and privacy. The bathroom and toilet align more with the verandah's positioning, reflecting their utilitarian role in the household.

Kampung Naga Village

In Kampung Naga, a traditional Baduy house, the spatial dynamics follow a similar pattern but with distinct cultural variations. The verandah has an RA of 0.40, meaning it's not as private as other parts of the house but also not fully open. Its integration value of 2.50 suggests moderate accessibility, while a control value of 0.58 shows it has a moderate influence on movement.

The kitchen, a vital part of the house, has an RA of 0.13, indicating that it is very central in the household layout. With an integration value of 7.50, it's clear that the kitchen plays a key role in everyday movement and interaction. A control value of 2.08 further supports this, highlighting its importance as a connector between different parts of the home.

Private areas like guest rooms and bedrooms have an RA of 0.46, meaning they are more isolated and private than communal spaces. Their integration values of 2.14 show these spaces are somewhat accessible but largely intended for retreat and rest. A control value of 0.25 reflects their limited influence on how people move through the house, as they serve more secluded functions.

The storage area, with an RA of 0.20, is more accessible but still somewhat private. Its integration of 5.00 and control value of 1.00 show that it balances function with seclusion. The living room, with an RA of 0.13 and high integration value of 7.50, plays a significant role in both social and private functions, much like the kitchen.

Taneyan Lanjhang in Bangkalan

In this traditional Maduranese house, the spatial arrangement is different but no less revealing. The bedrooms, known as Roma, have an RA of 0.23, indicating they are relatively integrated into the household's spatial system. With an integration value of 4.20, they strike a balance between privacy and accessibility. The control value of 0.64 suggests these rooms play a role in regulating access between spaces, balancing public and private areas effectively.

The central communal area, or Taneyan, stands out with RA and integration values of 0.00. This signifies its total integration within the home, meaning it acts as the communal heart that connects every part of the house. Its high control value of 3.33 emphasizes how central it is to regulating movement and activity within the home.

Other private spaces, like toilets, bathrooms, and the Musholla, share similar values with the bedrooms, blending privacy with accessibility. The kitchen, known as Dapoer, stands out with an RA of 0.19 and the highest integration value of 5.25, making it the most socially and functionally important space in the house.

5 Discussion

Incorporating Space Syntax theory, the analysis of Taneyan Lanjhang, Joglo Pati, and Kampung Naga traditional houses reveals distinct spatial interaction patterns. Taneyan Lanjhang and Joglo Pati, with their U-shaped layouts, demonstrate a high degree of spatial integration, particularly in communal areas like the Taneyan and kitchens. This aligns with Space Syntax's emphasis on connectivity and integration, where these communal spaces act as nodes of high interaction potential. The moderate Relative Asymmetry (RA) values in bedrooms indicate a blend of privacy and connectivity, typical of traditional residential settings where private and communal spaces coexist. The study by Xian et al. demonstrates that the highest value of RA has predominantly separate rooms, thus showing a higher level of spatial segregation. As a result, the rooms are generally more separated and less interconnected with one another [27].

Kampung Naga's architecture, on the other hand, shows a more pronounced distinction between public and private spaces. This is evident in the higher RA values for bedrooms, indicating a higher degree of isolation, and lower RA values for communal areas like the kitchen and living room, emphasizing their role as hubs of interaction. The modular design of Kampung Naga houses reflects a spatial organization where privacy is more distinctly segregated from communal activities, a characteristic highlighted by Space Syntax in terms of spatial segregation and integration.

These distinct patterns highlight the diverse ways traditional architecture can facilitate both community interaction and individual privacy.

1. The spatial configuration of the Joglo house in Juwana, Pati, as revealed through space syntax analysis, perhaps, significantly influences its microclimate, validating Xian's findings on thermal conditions[28]. The interview results indicate an increasing trend in the use of modern appliances over the years. This shift is driven by the desire for convenience and comfort, which modern appliances readily provide, meeting the evolving needs and preferences of users[29]. The open-plan arrangement, characterized by the connectivity and openness of spaces like the *pendapa* and *pinggitan*, maximizes natural ventilation. This interconnectedness allows for efficient airflow, effectively reducing the reliance on artificial cooling systems. Xian's thermal imaging study demonstrated that the roof height and building materials contribute to passive cooling, with temperatures decreasing at the top of the roof and cooler air maintained within the living spaces. Inversely with the condition in bedroom, that requires AC to promote more

desirable thermal condition causing by its enclosed and closed spaces. Such design elements not only enhance thermal comfort but also promote ecological sustainability by optimizing energy efficiency and minimizing electricity consumption from air conditioning. The clear avenues for air-flow in open spaces versus the more enclosed, air-conditioned bedrooms underscore the environmental benefits of this architectural approach.

2. Space syntax analysis of taneyan configurations shows a balance between local isolation and broader interconnectedness, supporting sustainable living. This layout enhances privacy and social interaction, promotes efficient space use, encourages movement and visibility, and supports agrobiodiversity (activities of drying rice, planting crops, etc.) through shared home gardens (taneyan Lanjhang) [17]. These insights demonstrate how traditional spatial designs can inform sustainable urban planning by balancing privacy, connectivity, and resource efficiency.
3. The study by Taufiq examines how local genius and sustainable architecture intersect in Kampung Naga, Indonesia. The spatial configuration enhances privacy within the communal setting, maintaining overall coherence and connectivity [15]. Justified Plan Graph analysis shows distinct spatial functions, with the kitchen as a central hub and private spaces maintaining lower integration values to ensure privacy. The study highlights the sustainable architecture in Kampung Naga includes minimal environmental disruption in house construction, preserving the natural landscape. Strategies like botanical gardens and green roofs promote biodiversity and climate regulation. Proper zoning and orientation ensure visual amenity, while sustainable practices support long-term community welfare. Buildings maximize natural light and airflow, reducing energy reliance. Efficient water management systems and the use of renewable materials minimize environmental impact and resource depletion. The reliance on low-energy solutions further reduces overall energy consumption.
4. This study expands on prior research by comparing the spatial configurations of Joglo Pati, Kampung Naga, and Taneyan Lanjhang, revealing a broader range of spatial designs than previously explored. While earlier work focused on traditional Javanese homes by Xian in 2023 [27], this study shows how different cultural contexts influence the balance between privacy and community. It highlights key differences, such as the high R^2 in Kampung Naga and low R^2 in Taneyan Lanjhang, illustrating variations in connectivity and visual accessibility across regions. By incorporating visibility analysis, it adds new insights into how spatial legibility shapes these vernacular architectures.

These findings align with the aim of uncovering the meanings embedded in these architectures and translating them into new forms that retain their essence with a fresh interpretation. Using Space Syntax to analyze spatial configurations, the study highlights how traditional structures foster social interaction and cultural expression. By identifying common threads in these architectures, the research pinpoints the core elements defining the heart and soul of traditional architecture. This approach emphasizes the three pillars of sustainability: ecological sustainability through efficient use of space

and natural materials, social sustainability by fostering community interaction, and preserving cultural heritage as a valuable asset.

6 Conclusion

The spatial configurations of Taneyan Lanjhang in Bangkalan, Joglo in Pati, and Kampung Naga village, analyzed through the lens of Space Syntax, reveal the cultural and social values embodied in architecture. While Taneyan Lanjhang and Joglo Pati emphasize a fluid integration between private and communal spaces, Kampung Naga presents a more compartmentalized approach, with clear demarcations between private and public areas. These differences in spatial organization not only reflect distinct cultural practices but also underscore the versatility of traditional architecture in accommodating communal living and individual privacy.

For instance, the Joglo house in Pati balances communal and private spaces, facilitating social interaction while maintaining individual privacy. The open-plan design, characterized by the *pendapa* (main hall) and transitional spaces, supports natural ventilation and reduces reliance on artificial cooling systems. This design aligns with sustainable practices by optimizing energy efficiency and promoting thermal comfort.

In contrast, the Taneyan Lanjhang houses in Alang-Alang village feature a U-shaped layout centered around a communal courtyard. This configuration enhances social cohesion and supports agrobiodiversity through shared home gardens. The balance between local isolation and broader interconnectedness fosters a sustainable living environment, reflecting the integration of privacy and community in traditional residential settings.

Kampung Naga's architecture emphasizes ecological sustainability and cultural preservation. The spatial arrangement prioritizes privacy while maintaining overall coherence and connectivity. The use of natural, locally sourced materials and the avoidance of electricity underscore the community's commitment to living harmoniously with nature. This approach not only preserves cultural heritage but also supports sustainable resource management.

The study's application of Space Syntax theory elucidates the relationship between spatial configurations and social interactions. The analysis of Relative Asymmetry (RA) and integration values reveals the dynamics of privacy, connectivity, and visibility within these traditional houses. The research underscores the importance of preserving the core elements of traditional architecture while translating them into modern forms that retain their essence. This approach aligns with the principles of sustainability by promoting ecological sustainability through efficient use of natural materials, fostering social sustainability through enhanced community interaction, and supporting economic sustainability by preserving cultural heritage.

While Previous study primarily examined public and private space separation, this paper expands the framework to include visual connectivity, revealing how spatial legibility and privacy differ across various regional architecture. However, The study's findings may be limited by the small number of case studies, which reduces the ability

to generalize the results to a broader context. While insightful, these conclusions should be further supported by research in different regions or architectural styles. Future studies should explore how traditional architecture adapts in modern urban settings to preserve cultural heritage amid rapid development.

Acknowledgements The authors gratefully acknowledge financial support from the Institut Teknologi Sepuluh Nopember for this work, under the project scheme of the Publication Writing and IPR Incentive Program (PPHKI) 2024. This research was also partly supported by *Pendanaan Penelitian Departemen Dana Unit Kerja Batch 2* Sepuluh Nopember Institute of Technology in 2024, Number: 1874/PKS/ITS/2024.

References

1. S. Kim and H. Kwon, "Designing for Modern Living: The Strategic Evolution of Residential Spaces in Response to Improved Lifestyles," *Teh. Glas.*, vol. 18, no. 2, pp. 234–245, May 2024, doi: 10.31803/tg-20231212071519.
2. H. Purnomo, J. O. Waani, and C. E. V. Wuisang, "GAYA & KARAKTER VISUAL ARSITEKTUR KOLONIAL BELANDA DI KAWASAN BENTENG ORANJE TERNATE," vol. 14, 2017.
3. R. PH, "Dialog Pengembangan Potensi Bentuk dan Ruang pada Arsitektur Tradisional Indonesia dengan Konteks Masa Kini dan Mendatang," *Pus. Penelit. Dan Pengemb. Pemukiman.*, 2016.
4. S. Soltani, N. Gu, J. J. Ochoa, and A. Sivam, "The role of spatial configuration in moderating the relationship between social sustainability and urban density," *Cities*, vol. 121, p. 103519, Feb. 2022, doi: 10.1016/j.cities.2021.103519.
5. F. A. Hamsjah, K. M. Ariana, R. N. Radhiyya, R. A. Tiarawati, N. E. Nuffida, and D. Novianto, "Study on The Influence of Colonial Architecture of Vernacular Environment," *Paragraphs Environ. Des.*, pp. 48–58, Aug. 2023, doi: 10.59260/penvid.2023.48582214.
6. I. Mayrafina, "Penyebab IKN Terancam Gagal Jadi Smart City dan Green City," *Fakta.com*, Aug. 26, 2024.
7. R. Soesilo, "TELAAH FILOSOFIS ATAS ARSITEKTUR DIGITAL Kasus Studi Arsitektur Digital Neo-Nusantara di Ibu Kota Negara (IKN)," *JoDA J. Digit. Archit.*, vol. 2, no. 1, pp. 3–8, Nov. 2022, doi: 10.24167/joda.v2i1.5542.
8. R. T. Hidayat, A. E. Sumanti, A. N. Rosyad, D. Novianto, and D. Sekartaji, "Kampung Naga from the Perspective of Sustainable Development Goals."
9. J. Adiyanto, "ARSITEKTUR SEBAGAI MANIFESTASI IDENTITAS INDONESIA," *NALARs*, vol. 21, no. 2, p. 139, Jul. 2022, doi: 10.24853/nalars.21.2.139-150.
10. J. Prijotomo, "About Nusantara Architecture: a Matter of Either-or or Both-and toward Place for Better Living in the Humid Tropic," *Int. J. Livable Space*, Apr. 2016, doi: 10.25105/livas.v0i0.52.
11. N. Solikhah and A. F. Bere, "Vernacular Architecture as a Representation of Nature, Self, Culture, and Society: Insights from Sumba-Timor-Flores.," presented at the International Conference on Economics, Business, Social, and Humanities (ICEBSH 2021), Jakarta, Indonesia, 2021. doi: 10.2991/assehr.k.210805.237.
12. S. Subiyantoro, "The Interpretation of Joglo Building House Art in the Javanese Cultural Tradition," vol. 26, no. 3, 2011.
13. I. Widiastuti, *Architecture of the Society Practicing Matrilineal Kinship in Nusantara: An attempt to build a knowledge body*. 2015.

14. H. A. H. Almunawaroh, "Tanean Lanjhang, Madurese Traditional House, Symbol of Strong Kinship and Harmony Tanean of Love," *J. Ilm. Penelit. Multidisiplin*, vol. 1, no. 1, Art. no. 1, Feb. 2024.
15. T. R. Nuzuluddin and T. S. Andadari, "KAJIAN LOCAL GENIUS ARSITEKTUR KAMPUNG NAGA TERHADAP SUSTAINABLE ARCHITECTURE," *Neo Tek.*, vol. 3, no. 2, Dec. 2017, doi: 10.37760/neoteknika.v3i2.1415.
16. B. A. Wibawa, K. Widiastutui, and V. Nindita, "EKSISTENSI DAN KEBERLANJUTAN KAMPUNG JOGLO DALAM MASYARAKAT, BUDAYA DAN LINGKUNGAN ASLINYA," *J. Tek. Sipil Dan Arsit.*, vol. 24, no. 1, Jan. 2019, doi: 10.36728/jtsa.v24i1.819.
17. R. T. Maningtyas and A. Gunawan, "Taneyan Lanjhang , Study of Home Garden Design Based Local Culture of Madura," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 91, p. 012022, Oct. 2017, doi: 10.1088/1755-1315/91/1/012022.
18. V. M. Shams and A. Rezvani, "Spatial Organization Analysis of The Historical and Contemporary Houses in Mashhad by Using the Space Syntax Method."
19. Gierlang Bhakti Putra, "Teknik Convex Mapping: Analisis Visual Space Syntax yang Bermanfaat bagi Pemula," *J. Lingkung. Binaan Indones.*, vol. 11, no. 2, pp. 71–76, Jun. 2022, doi: 10.32315/jlbi.v11i2.31.
20. R. T. Hidayat, A. E. Sumanti, A. N. Rosyad, D. Novianto, and D. Sekartaji, "Kampung Naga from the Perspective of Sustainable Development Goals."
21. Y. Darusman, "Kearifan Lokal dan Pelestarian Lingkungan (Studi Kasus di Kampung Naga, Kabupaten Tasikmalaya, dan di Kampung Kuta, Kabupaten Ciamis)," *J. Pendidik. Dan Kebud.*, vol. 20, no. 1, pp. 140–154, Mar. 2014, doi: 10.24832/jpnk.v20i1.128.
22. N. C. Idham, "Javanese vernacular architecture and environmental synchronization based on the regional diversity of Joglo and Limasan," *Front. Archit. Res.*, vol. 7, no. 3, pp. 317–333, Sep. 2018, doi: 10.1016/j.foar.2018.06.006.
23. A. Santosa, M. Rachmawati, and V. T. Noerwasito, "Material and Cultural Values in Joglo Architecture in Indonesia," vol. 10, no. 2, 2023.
24. S. B. Puri Bahesa and N. Nurudin, "Etnografi Komunikasi Masyarakat Taneyan Lanjhang Sebagai Identitas Budaya Pamekasan," *J. Penelit. Dan Pengemb. Sains Dan Hum.*, vol. 5, no. 3, pp. 474–480, Sep. 2021, doi: 10.23887/jppsh.v5i3.36631.
25. D. Novianto, R. T. Hidayat, and S. A. D. Bhanuwati, "Pemetaan Arsitektur Tradisional Taneyan Lanjhang Madura: Studi Kasus Desa Alang-Alang, Kecamatan Tragah."
26. A. B. Sardjono, "KERAGAMAN PERUBAHAN PADA RUMAH TRADISIONAL JAWA DI PEDESAAN," 2015.
27. G. E. Xian, D. Novianto, and I. Defiana, "Investigate Sustainability Aspect in Spatial Configurations of Javanese Vernacular Architecture: Case Study of Joglo House."
28. G. E. Xian, A. E. Sumanti, R. T. Hidayat, S. Sudo, and D. Novianto, "Reconsidering Occupant's Lifestyle: Investigation on the Sustainability of Modernized Javanese Vernacular Architecture," *Civ. Eng. Archit.*, vol. 12, no. 3A, pp. 2482–2490, May 2024, doi: 10.13189/cea.2024.121338.
29. A. E. Sumanti, G. E. Xian, R. T. Hidayat, T. C. Julian, and D. Novianto, "The Energy Use and Living Behavior in Urban Retrofit Vernacular Architecture," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 1361, no. 1, p. 012016, Jul. 2024, doi: 10.1088/1755-1315/1361/1/012016.

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

