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Application of Tropical Architecture Concept in Sulah Nyanda House of Baduy Traditional Village

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ABSTRACT

Baduy Traditional Village, located in the interior of Lebak Regency, Banten, reflects strong local wisdom in utilizing natural resources through traditional architectural design. Sulah Nyanda house, as part of Baduy settlement, is designed to face the challenges of tropical climate and preserve traditional values. This research aims to analyze the application of tropical architecture concept in Sulah Nyanda traditional house, focusing on meso and micro scale. The research method uses a qualitative approach based on literature study, including descriptive analysis of various sources such as books, scientific articles, and related reports. The analysis includes observations of building orientation, local materials such as bamboo and palm fiber, and other architectural features that support thermal comfort. The results show that Sulah Nyanda houses are designed with a north-south orientation to maximize natural ventilation and lighting. The stilt structure helps reduce soil moisture, while the woven bamboo walls support air circulation. The lack of windows not only reflects the simplicity value of the Baduy community but also enhances privacy and security. Sulah Nyanda House is not only a manifestation of the local wisdom of the Baduy community, but also evidence of adaptation to a sustainable tropical climate, while reflecting sustainable cultural values.

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1. INTRODUCTION

Indonesia, as an archipelago consisting of around 18,108 islands, is inhabited by various ethnic groups and tribes that create a very rich cultural diversity. Based on data from the Central Statistics Agency (BPS) quoted from the Indonesian Information Portal (2017), Indonesia has around 300 ethnic groups with a total of 1,340 ethnic groups. This diversity provides its own color in social, cultural, and architectural life in Indonesia. Architecture as a cultural product reflects the relationship between humans, nature, and the culture that develops around it. Rapoport (in Septianto & Suparman, 2014) explains that culture includes all ideas, customs, and activities that are conventionally practiced by society, while architecture acts as a link between human culture and the surrounding environment. Architectural materials generally come from nature and are selected and processed according to local cultural traditions (Owen in Sardjono & Nugroho, 2017).

Vernacular architecture is a form of architecture that has a local character and is strongly influenced by local cultural, social, economic, and environmental conditions. Vernacular buildings usually use local materials that are easily found around their place of residence and are designed to adapt to the local climate (Heryati & Abdul, 2014). According to Antariksa et al. (2022), vernacular architecture reflects local wisdom resulting from the interaction between people and their environment. In this context, Paul (in Mahanggi, 2018) mentions several environmental elements that are approached in vernacular architecture, such as climate, location and site, natural disasters, and population and settlements. Vernacular houses are designed by considering the climatic conditions and the environment where the house stands. Paul Oliver (in Widi & Prayogi, 2020) states that vernacular house design is influenced by the environmental context, using local resources and traditional technologies. Supriyono et al. (2018) adds that vernacular architecture develops within the community, uses materials from the surrounding environment, and stands as a response to the environment that has evolved through years of experience. One of the main factors in home comfort is how the building design can respond to local climatic conditions, especially in terms of temperature, humidity, and airflow that play a role in creating thermal comfort (Rahardja in Setyohadi, 2011).

Baduy Traditional Village, located in the interior of Lebak Regency, Banten, is one example of a community that highly values nature preservation. The Baduy community has a lifestyle that is highly dependent on nature, which is not only seen as a resource, but also as a sacred entity that must be maintained and respected (Sardjono & Nugroho, 2017). They maintain a harmonious relationship between humans and nature, which is reflected in their simple yet functional vernacular architectural designs. Baduy houses made of natural materials such as bamboo and wood are designed to adapt to the local climate and environmental conditions. The main principle of Baduy community is to maintain the balance between human and nature, which is realized through customary rules that prohibit forest destruction and excessive exploitation of natural resources (Suryani, 2014).

The study of Baduy Village highlights the integration of sustainable architecture and local wisdom in the traditional houses of the Baduy community. Sustainable architecture in Baduy Village seeks to reduce environmental impact through efficient use of materials and energy, with techniques such as *rammed earth* and clay bricks (Reddy & Sri, 2023). The traditional architecture of the archipelago including in Baduy, reflects a deep respect for the natural environment and integrates local wisdom in sustainable practices (Wasilah,2023). In addition, environmental management by the Baduy community is based on local wisdom that prioritizes living in harmony with nature. This can be seen from unique practices that protect natural resources, as well as settlement arrangements and house designs that prioritize

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health and environmental preservation (Kenedy & Deffinika, 2022; Widayati et al., 2018) . However, the landscape of Inner Baduy faces challenges such as limited agricultural land and high population growth. To overcome these challenges, a locally-based landscape plan has been developed that balances land use for agriculture and conservation (Septini & Pramukanto, 2022). While Baduy Village models sustainable living, it also faces modern challenges such as population growth and land scarcity. These challenges require innovative solutions that honor traditional practices while adapting to contemporary needs. Integrating local wisdom with modern sustainable practices is essential to effectively address these challenges.

Various previous studies on Baduy Village have made important contributions to the understanding of traditional architecture. For example, Widyarti et al. (2012) examines the passive air condition in Baduy Dalam houses, Sardjono & Nugroho (2017) discusses sustainable architecture in Baduy community settlements, Widyarti et al. (2011) reviewing the concept of *ecohouse* in Baduy Dalam houses, and Susilowati et al. (2020) examined the evolution of traditional house layout of Baduy community. However, this research offers *novelty* in the form of an in-depth analysis of the application of tropical architecture concept in Sulah Nyanda house in Baduy Traditional Village. This research examines the adaptation of Sulah Nyanda house design to the tropical climate, such as the arrangement of ventilation, the utilization of local materials, and the application of passive design principles that focus on thermal comfort. In addition, this research also highlights the synergy between the local wisdom of the Baduy community and the principles of tropical architecture, thus making a new contribution to the study of traditional architecture that is contextual to environmental issues.

2. RESEARCH METHODS

This study on the various characteristics of tropical architecture concept application in Baduy Traditional Village uses a qualitative approach. The qualitative approach involves descriptive analysis of the study location observation, landscape concept, building, local wisdom of Baduy Tribe and tropical architecture concept in Baduy Traditional Village which is conducted through literature study method. Qualitative method with descriptive analysis technique is a method based on post positive philosophy to research natural objects with the researcher as the key instrument (Sugiyono, 2013). This study goes through several stages including the preparation stage, data collection and data analysis as follows:

A. Preparation Stage

The preparation stage starts from selecting the topic and location of the study and determining the main focus of the study. After that, a preliminary study was conducted to understand the topic and tropical landscape of the village in Baduy Inland through a review of the literature relevant to the study. This review helps the study in getting an overview of the location, regional landscape and local wisdom of Baduy Tribe. The variables studied include regional landscape, traditional architectural building, local wisdom and the application of tropical architecture concept.

B. Data Collection Stage

The second stage is the data collection stage carried out through the literature study method including books, scientific articles and other sources relevant to the research. The literature sources used were selected based on criteria relevant to the topic and location of the research.

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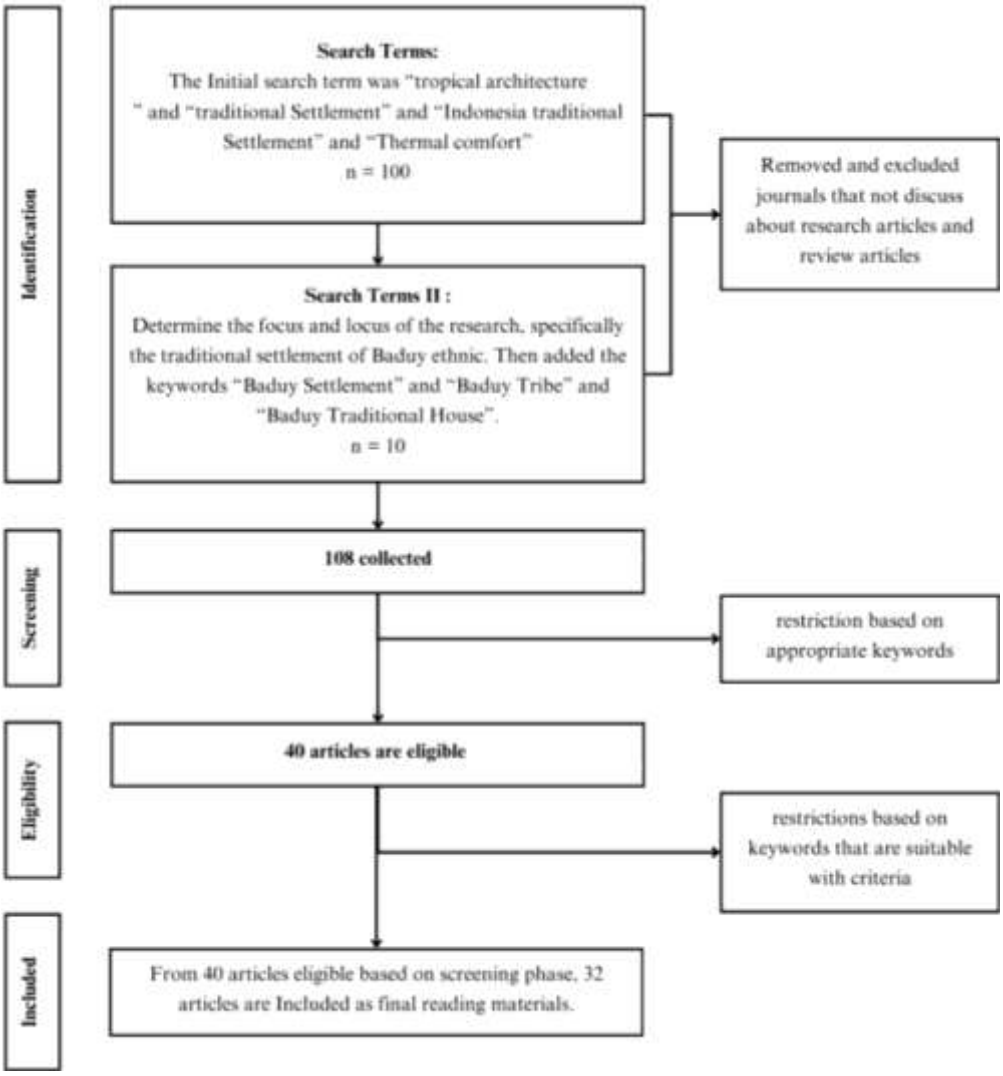

Figure 1: Data Collection Stages Literature Study
(Source: Personal Document)

C. Data Analysis Stage

The stages of data analysis go through several steps including descriptive analysis which is carried out to describe the data that has been collected from the literature study. This analysis aims to understand the existing condition of Baduy Traditional Village location. Furthermore, it analyzes the existing landscape concept in the interior of Baduy Traditional Village and the last is the analysis of the tropical concept in Baduy Traditional Village. Evaluation of the application of tropical architecture concept in Sulah Nyanda House, Baduy Tribe is conducted based on indicators including building orientation, local materials, stage structure form, natural ventilation, settlement layout, surrounding vegetation, *semi-outdoor* space and thermal performance. Qualitative descriptive analysis is used to describe the elements in the indicators, which are then synthesized with tropical architecture theory to assess the effectiveness and integration between the indicators. Conclusions were formulated based on the level of application of Sulah Nyanda traditional house design in the concept of tropical architecture, as well as providing recommendations for the preservation of traditional architecture.

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Figure 2. Research flow diagram
(Source: Personal Document

3. RESULTS AND DISCUSSION

3.1 Identification of Location and Study Object

A. Location

The Baduy tribe is located in Kanekes Village, Leuwidamar District, Lebak Regency, Banten. Kanekes area is geographically located at the coordinates of 6°27'27" - 6°3°'0" LU and 108°3'9" - 106°4'55" East. Based on the Regional Regulation of Lebak Regency Number 32 Year 2001 on the Protection of Customary Rights of Baduy Community, Chapter III Article 6, Baduy customary land is bordered by Cibungur Village and Cisimeut Village in the north (Leuwidamar District), Sobang Village in the east (Cipanas District), Cigemblong Village in the south (Bayah District), and Karangnunggal Village in the west (Bojongmanik District). Baduy Customary Land, known administratively as Kanekes Village, has an area of 5,136.38 hectares. This area has been determined by the State Land Agency (BPN) and formalized as the Communal Land of the Baduy Community according to Regional Regulation Number 32 of 2001. The Baduy tribe lives at the foot of the Kendeng Mountains, about 40 kilometers from the city of Rangkasbitung. The topography is hilly and undulating with an average slope of 45°. The soil type in this area varies, with volcanic soil in the north, sedimentary soil in the center and mixed soil in the south. The Baduy people refer to themselves as Kanekes people, because they live in Kanekes Village. Their settlements are located around the Ciujung and Cikanekes rivers in the Kendeng Mountains.

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The Baduy tribe is one of the indigenous communities in Indonesia who live in several villages, such as Gajebo, Cikeusik, Cibeo, and Cikertawana. They are divided into two large groups, namely Inner Baduy and Outer Baduy. The area where they live has an area of about 1,348 hectares, which is inhabited by 117 family heads. The members of this community live in 99 traditional stilt houses called Sulah Nyanda. These houses are characteristic of Baduy's traditional architecture that maintains traditional values. In addition to residential houses, there is also a kokolot house or what is known as "duku." The duku house, called Dangka, has a distinctive position as it always faces south.

The Baduy are administratively located in Kanekes Village, where most of them live in around 20 traditional villages. However, there is a special group known as Baduy Dangka who live outside the Kanekes Village area. The environment where the Baduy live has cool tropical climatic conditions, with an annual average temperature of around 26.5°C. The lowest temperature is usually recorded in February, with the lowest temperature recorded in February. The lowest temperature is usually recorded in February, which is around 26.1°C, while the highest temperature occurs in May, September, and October, which reaches 26.8°C. Rainfall in the area is moderate, with a monthly average of 171.1 mm. In addition, the average air humidity reaches 81%. The highest humidity level occurred in February, at around 85%, while the lowest humidity was recorded in August and September, at 76% each. This information reflects the environmental condition of Kanekes Village, which supports the lifestyle and traditional habits of the Baduy community (Pratami & Pramukanto, 2017).

Figure 3. Map of Kanekes Village Area
(Source: News.detik.com, 2017)

B. Object of Study

In Baduy Traditional Village, there are several types of buildings, including the house of the customary leader, *Sulah Nyanda* (a house of residents with the same shape), *leuit* building, and latrine building used as a shared facility. In this article, the object analyzed for its tropical architecture concept is the Sulah Nyanda House. This stilt house has a north-south orientation.

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Made from materials from the surrounding, wood is used as a pole, bamboo for walls, and coconut leaves as a roof (Mustopa, 2023).

Picture 4. Sulah Nyanda's house
(Source: Harapan, 2019 and Personal Documents, 2024)

The outer Baduy traditional house has a spatial layout that is divided into several main parts with different functions (Susilowati et al., 2020). *Imah* is the main space as the center of activity, residence, family room, and gathering place. *Tepas*, a semi-private space, is a gathering place for family and guests of close relatives, and is often used for eating and warming the body. Tepas are usually close to the *parako* as a place to cook and keep warm. *Goah* serves as storage and kitchen. Meanwhile, *golodog* or *sosompang* is the front porch which is the entrance to the house and acts as a transition area from the outside environment to the inside of the house. The traditional house of the Inner Baduy Tribe has a simpler layout, consisting of *imah, sasoro* (living room) and *tepas.* There are three house models according to the number of family heads, which is determined by the number of parako or fireplaces. Houses with three heads of families are now rarely found.

3.2 Identification of the Application of Meso-scale Tropical Architecture Concepts

A. Settlement Planning

In general, the Baduy community is divided into three groups, namely *tangtu*, *panamping* and *dangka*. The *tangtu* and *panamping* groups are in the area of Baduy village (Kanekes), while the dangka are outside Kanekes Village. Based on the level of purity and obedience to custom, *tangtu* is considered higher than *panamping*, and panamping is higher than dangka. *Tangtu* refers to Inner Baduy, while *panamping* and *dangka* refer to Outer Baduy. The land where the *tangtu* community lives is considered sacred by all Baduy people. Meanwhile, the word *panamping* comes from the word *tamping* which means 'dump', so *panamping* can be interpreted as 'dumping place'. Thus, *panamping* is a place for *tangtu* people who are expelled or expelled for violating customs. Meanwhile*, dangka*, according to some opinions, means *'frame'* or 'dirty', referring to a place for Baduy people who violate custom (Susilowati et al., 2020).

Figure 5. Baduy Community Settlement
(Source: *iNews Lebak*)

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Baduy settlements are in the form of clusters that are tightly lined up so as to support a close social life and minimize land requirements to help preserve nature. In addition, the settlements are located close to the river flow and agricultural land. The Baduy community places nature as an integral part of their life, so settlements and agricultural land are organized with the principle of sustainable coexistence. Based on Chairuman's (2024), Baduy settlement is usually located near the river. In Cibeo Village, the settlement stretches from north to south. There is an open space in the center of the village called alun-alun *(buruhan)* with a square shape. At the north end, there is a meeting hall. Next to the hall, there is a house with a *long mortar* (where women pound rice). On the west and east sides of the square, there are rows of houses arranged in groups and facing each other. The type of building in Baduy settlement consists of a traditional chief's house, community house, *leuit* (rice barn) and latrine.

B. Vegetation

The forest area in Baduy Traditional Village is divided into three categories, namely forbidden forest, *Dudungusan* forest (protected forest), and cultivated forest. The prohibition forest is located in the southern part of Baduy *Tangtu* settlement, in the deepest and highest area of all forest areas in Baduy. It contains various types of tall wood trees with dense crowns, as well as various perennials and other trees. The surface of the forest is covered by various types of plants such as palms, ferns, shrubs, vines, and moss. The larangan forest is considered an important resource that maintains the balance of the ecosystem and provides water that flows into the river. However, the area of the prohibition forest is currently decreasing. The threat is caused by residents outside Baduy, such as logging, land grabbing, and taking fish in the river with poison. Internal disturbance that occurs, among others, is the relatively rapid growth of Baduy population (Suparmini et al., 2013). The *dudungusan* forest is basically the same as the prohibition forest, which must be preserved. The natural potential of this forest is still protected, but Baduy community is allowed to utilize forest products in a limited way. The arable forest is used as agricultural land, such as field or huma, for various crops such as rice and garden commodities. The cultivated forest is a land functioned for long-term agriculture, where food crops and intercropping can be planted.

Vegetation types in Baduy area have ethobotanical functions and certain benefits for people's lives. There are 41 types of vegetation and their utilization (Chairuman, 2024). Some of them are: bamboo, vetiver, calliandra, lamtoro, turi, sengon, mahogany, teak, bendo, karangkungan, aren palm, banana, rambutan, coconut, turmeric, ginger, kencur, trembesi, banyan, lemongrass, breadfruit, tahi ayam, gamai and orok-orok. The layout of plants around the Baduy house does have certain principles related to their beliefs and way of life which is oriented towards harmony with nature. Although there are no too clear rules about the types of plants that should be around the house, there are some general patterns and spiritual meanings behind the planting of these plants. The type of plant that is often planted around the house is coconut tree which is considered to provide protection, the trunk of coconut tree is used as the frame of Baduy community building (Suryani, 2014). Coconut fiber is also used for roofing or kirai on leuit (rice barn) and houses (Suparmini et al., 2013). Banana trees are also often found around houses, in some indigenous people's beliefs, bananas are considered to bring good luck and prosperity. Betel plants are often planted around the house as a symbol of harmony and protection. Betel is also used in various traditional rituals and religious ceremonies, besides that betel plants are also used by the Baduy community as a substitute for toothpaste, because betel leaves are believed to have antibacterial effects (Sidik et al., 2020). Betawi pandanus plants are also planted around the house and used as traditional medicine.

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The Baduy highly value their relationship with nature, planting plants around the house also illustrates harmony with the universe. Teak trees are considered sacred and respected by the Baduy Tribe as a symbol of resilience and peace. Its existence around the house is considered important in maintaining harmony with nature. Baduy people use teak wood as the main structure of the house (Suparmini et al., 2013). Palm trees are often found around Baduy houses and are considered a symbol of togetherness and sustainability. Baduy tribe utilizes every part of bamboo in their daily life. In addition, the land used by bamboo clumps is known to be very fertile and ideal for farming (Suryani, 2014). Bamboo stalks are woven to be used as the walls of leuit and houses of the Baduy community (Suparmini et al., 2013). The floor of the building is also made using bamboo stalks. Bamboo is also used to make various household furniture, such as drinking containers, clean water collection tools, vegetable oil storage for lighting, and trash cans (Sardjono & Nugroho, 2017).

The types of plants used for daily food needs are planted in *huma* or fields, the types of plants are very diverse. Rice is a plant that is considered sacred by the Baduy community, all rice planting activities are regulated by *pikukuh* or customary leaders. For Baduy community, the activity of planting rice is a form of worship and sacred ritual as a tribute to Nyi Pohaci Sanghyang Asri in their belief (Suryani, 2014).

3.3 Identification of Micro-scale Application of Tropical Architecture Concepts

A. Building Orientation

The orientation of the building must be adjusted, namely by avoiding the negative side so that the intensity of the incoming sun is not excessive. In addition, determining the orientation will also affect the wind entering the building (Suprayitno, 2018) . Building orientation in the tropics should face south and in the direction of the wind (Nugroho, 2021). The location of the Baduy house is determined by considering the proximity to natural resources, but still maintaining a distance from the sacred area to preserve the ecosystem. The orientation of the house faces north or south to maximize natural lighting, following customary rules that ensure ecological sustainability. Houses in Baduy traditional village are oriented to utilize the natural wind direction that brings cool air from the hills or valleys. In the tropics, the placement of building masses also affects the airflow inside, where the position of buildings in a row can produce small air movements between buildings (Latifah et al., 2013). Baduy community settlements have a tightly lined form, this can reduce direct solar heat exposure so that the environmental temperature is more stable.

Figure 6. Baduy Settlement in The Form of Parallel dnd Close Together
(Source: Cerdika, 2023)

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B. Building Form

The buildings of Baduy Traditional Houses have a linear shape which is considered the most effective in capturing the wind, helping to create a comfortable temperature inside the house (Latifah et al., 2013). In addition, the difference in floor height or stage shape is very suitable for the tropical climate because it can reduce heat radiation from the ground and humidity (Latifah et al., 2013; Nugroho, 2021).

Figure 7: FloorPlan of the Outer Baduy House
(Source: Harapan, 2019)

Figure 8. Traditional chief's house
(Source: Harapan, 2019)

Figure 9. Residents' Houses
(Source: Harapan, 2019)

Figure 10. House Type with 1 Household
(Source: Susilowati, 2020)

Figure 11. House Type with 2 Households
(Source: Susilowati, 2020)

Figure 12. House Type with 3 Households
(Source: Susilowati, 2020)

C. Roof Sheathing

Roof sheathing in the tropics should be designed to have a large volume, namely by raising the ceiling of the house so that the comfort of the house temperature can be met (Supriyono et al., 2018). Sulah Nyanda house has a roof height of about 4 meters from the floor, because there is no ceiling in the house, the roof volume becomes larger. The slope on the roof of a tropical house is very important to drain rainwater, terraces are also needed for rainwater protection and solar heat (Nugroho, 2021). The roof of this house has a fairly high slope and is equipped with a terrace so that it is in accordance with the concept of a tropical roof. The choice of materials is no less important, materials with bright colors, low conductivity and

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high resistance are needed to minimize heat transfer (Budhyowati, 2022). The roof frame uses wood and bamboo utu with a diameter of 4-6 cm with palm fiber or coconut leaves as the roof covering (*kirai*) of this house. The use of this material is suitable in tropical areas because it is lightweight, good thermal insulation, and environmentally friendly. However, palm fiber or coconut leaf roofing material needs regular maintenance because it is in the humid tropics.

Figure 13: Roof of Sulah Nyanda House
(Source: Personal Document, 2024)

D. Wall Sheathing

The wall material used in the Sulah Nyanda House of the Baduy Tribe is a woven bamboo wall. This wall is estimated to last for 5 years. The woven bamboo wall has porous properties so that it can facilitate air to enter the building.

Figure 14: Woven Bamboo Wall
(Source: Harapan, 2019)

E. Floor

The material used on the floor is bamboo material that is split into small pieces. While at the bottom there are blocks of whole bamboo used to support the floor structure.

Figure 15. Floor covering material
(Source: Harapan, 2019)

Figure 16. Bamboo Floor Support
(Source: Harapan, 2019)

F. Building Spaces

The smooth flow or circulation of air in a space arrangement can be achieved by making ventilation holes in the fields that face each other (cross ventilation) (Suprayitno, 2018). In

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addition, the spatial arrangement also affects air movement, which is related to the design and placement of openings. In the Sulah Nyanda House, the spaces are simple and open, allowing for airflow. According to customary rules, the house can only have windows on the part that leads directly to the ground, so windows are not on each side of the building (Mustopa, 2023). Although the openings in the house do not face each other and do not allow cross ventilation, air can still flow through the gaps in the bamboo walls and the gaps between the walls and the roof.

Figure 17: Airflow in Sulah Nyanda House
(Source: Personal Document, 2024)

G. *Semi-Outdoor* Space

In the context of Baduy House, the existence of *semi-outdoor* space has a function similar to the concept proposed by Handoko & Ikaputra (2019) about the importance of *semi-outdoor* space to increase comfort. In the spatial layout of Baduy traditional house, this *semi-outdoor* space is realized through *sosompang*, which is a semi-public terrace that becomes a social interaction area. *Sosompang* allows for better air circulation, providing a sense of comfort for residents and guests. In addition, the existence of this *semi-outdoor* space supports the life pattern of Baduy community that emphasizes the value of togetherness and social interaction, as well as being a transition between private space and outdoor space, as suggested by Harapan (2019) in the concept of custom house layout in general). In Outer Baduy House, this part of the terrace has undergone functional adaptation by being widely used as a trading area for community handicraft products, reflecting the socio-economic dynamics that develop in the community.

Figure 18. Trading Activities in Semi-Outdoor Space of Outer Baduy Tribe House
(Source: Google.com)

Figure 19. Socialization Activity of Baduy Community in Semi *Outdoor* Space
(Source: *goodnewsfromindonesia.id*)

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H. Placement and Orientation of Openings

Baduy Traditional House is in the form of a stage with walls made of woven bamboo which allows small holes as natural ventilation. Based on the theory of Imran (2018), the optimal potential for air conditioning in this house can be achieved through holes in the wall that function as *inlets* for air entry. The position of these ventilation holes seems to be in accordance with the theory of Latifah et al. (2013), which is at a height of 0.5-0.8 meters from the floor to support air circulation. In addition, the high roof structure of this house supports natural ventilation through the stack effect of hot air escaping upwards. With lightweight and *permeable* woven walls, this house also has the potential to meet the SNI 03-6572-2001 standard, where residential ventilation must reach a minimum of 5% of the floor area, although detailed calculations are still needed to ensure its feasibility.

Figure 20. Baduy traditional house
(Source: Orami.co.id)

Figure 21. Columns, Doors and Windows
(Source: Harapan, 2019)

I. Opening Type

The type of opening in a vernacular building affects the amount of air that can enter. According to Latifah et al. (2013), different opening angles affect the direction and effectiveness of incoming airflow. Meanwhile, Arifah et al. (2017) states that the ideal openings for thermal comfort should be able to direct the air maximally into the room, support circulation and optimal air turnover, regulate the rate of air *flow (air flow*), and flexible to open or close as needed. Openings in the form of doors and windows in the Sulah Nyanda House are *side hung* types that can be opened and closed as needed. Each opening is also equipped with shading in the form of roof trellises.

Figure 22. Openings in the Sulah Nyanda House
(Source: Personal Document, 2024)

J. Opening Dimension

The dimensions of the door opening in Sulah Nyanda Baduy House are adjusted to the average height of the Baduy community, which is between 150 cm and 170 cm, with a width between 60 cm and 70 cm.

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Figure 23. Door Openings in the Sulah Nyanda House
(Source: Personal Document, 2024)

In Sulah Nyanda House, window openings are rarely found. The dimensions also vary depending on the needs and function of the room. The window dimensions in this traditional house usually have a width of between 30 cm and 50 cm with a height that is adjusted to the needs. Windows are rarely found because the woven bamboo material used on the walls can provide air circulation through the holes. In addition, the lack of windows reflects the life attitude of Baduy people who prioritize simplicity, integration with nature, and can increase the safety of the house from the threat of wild animals.

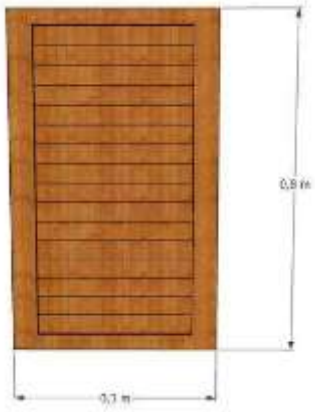

Figure 24. Window Openings in the Sulah Nyanda House
(Source: Personal Document, 2024)

K. Thermal Performance of Sulah Nyanda House

Research related to the thermal performance of Rumah Sulah Nyanda by Widyarti et al. (2012) was conducted in November 2009. The results of research related to thermal performance of Rumah Sulah Nyanda Baduy showed an increase in temperature at 06.00 WIB when the sun began to rise. However, the temperature increase occurs significantly at 9:00 am until 1:00 pm. The maximum temperature occurs at 12:00 a.m., reaching 34.16°C in the east sosoro room, while in the west sosoro room the temperature is relatively lower, 33.18°C, because the sun at that time is in the south latitude while the imah room is located in the northwest and covered by the chamber wall. The temperature dropped from 2:00 p.m. to 6:00 p.m. after which it reached 23°C and stabilized throughout the night. The lowest temperature reached 22°C at 05:00 am. Thermal performance that occurs in the building is influenced by the temperature of the outside environment as well.

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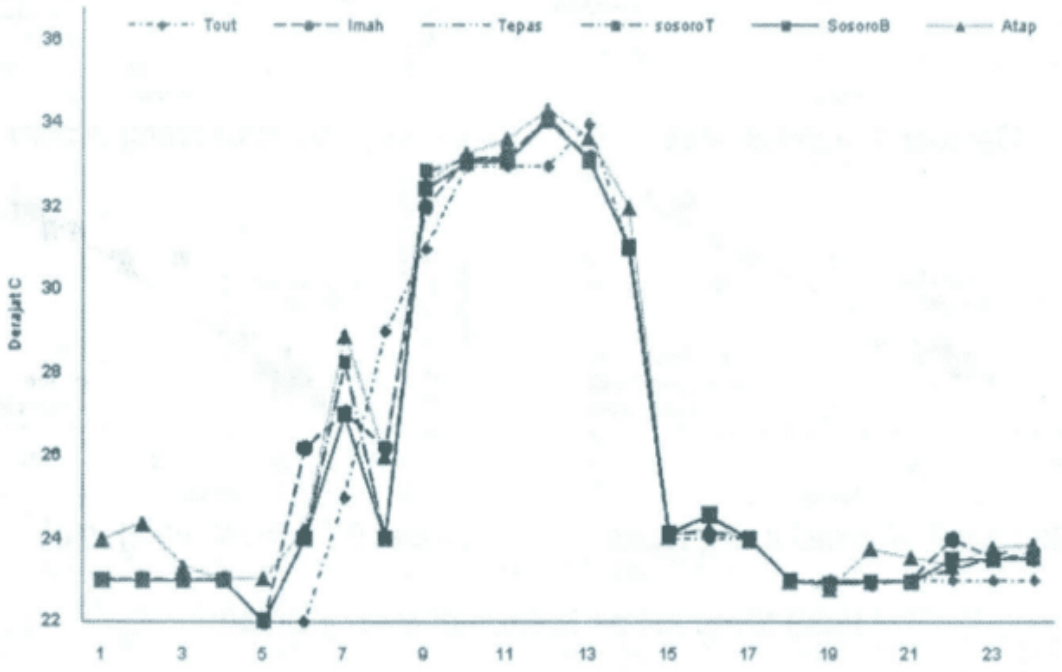

Figure 25. Thermal performance of Sulah Nyanda Baduy House
(Source: Widyarti et. al., 2009)

3.4 Concept and Integration

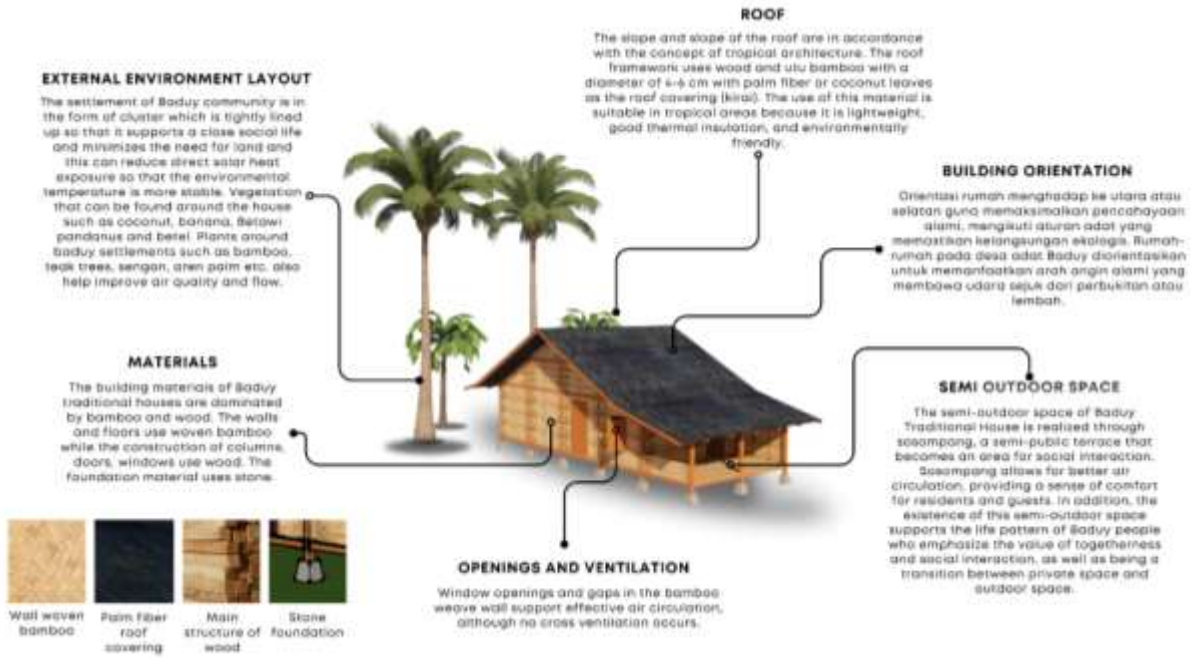

Figure 26. Formulation of Tropical Architecture Concept
(Source: Personal Document, 2024)

A. Integration of Sulah Nyanda House with its Environment

Baduy traditional houses reflect harmonious integration with the surrounding natural environment. Their settlements are tightly designed in the form of clusters, maximizing the efficiency of land use to preserve the ecosystem while reducing heat exposure so that the ambient temperature is more stable. Houses on stilts with natural materials such as bamboo, wood, and palm fiber are not only environmentally friendly but also support natural air circulation through the gaps in woven bamboo walls and high roof structures. The layout of houses facing north or south follows the principle of adaptation to tropical climates, utilizing

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natural lighting and wind flow for thermal comfort. Plants around the house, such as bamboo, coconut and banana, are selected based on their ecological and spiritual functions, reflecting the value of harmonious coexistence with nature. The existence of *semi-outdoor* spaces such as *sosompang* also strengthens social interaction while supporting air circulation, showing the integration of Baduy house design with social, ecological, and tropical climate needs.

B. Integration of Roof Elements and Space Volume with Air Circulation and Openings

The integration of roof elements and space volume in Baduy traditional houses is strongly related to air circulation and openings, which support thermal comfort in tropical environments. The high roof of a Baduy house, with sufficient slope, allows for optimal natural ventilation. With the large volume of the roof, hot air collected in the lower rooms can be lifted up, while cool air from outside can enter through openings located in the porous woven bamboo walls. This creates natural air movement, keeping the temperature inside the house comfortable even in the humid and hot tropics. Openings in Baduy houses are designed to support good air circulation. Openings in the form of doors and windows that can be opened and closed provide flexibility in regulating airflow as needed. In addition, these openings not only function as air inlets, but also maintain effective air exchange. The placement of the openings, coupled with the woven bamboo walls that have small gaps, ensures that air can move freely within the space. Overall, the integration of high and spacious roof elements, along with the design of openings tailored to ventilation needs, creates a cool and comfortable home. It also reflects the harmony between the architectural design of the Baduy house with the tropical climate conditions and the way of life of the people who value a harmonious relationship with nature.

C. Integration of Cultural Adaptation Elements to Climate with *Semi-Outdoor* Spaces

The integration of cultural adaptation elements to climate with *semi-outdoor* spaces in Baduy traditional houses reflects the balance between functional needs and the principle of living in harmony with nature. In the context of Baduy traditional house, the existence of *semi-outdoor* spaces, such as *sosompang* (semi-public terrace), plays an important role in responding to the humid and hot tropical climate. This space not only functions as a place for social interaction, but also as a transition space between the outside environment and the private space inside the house. With their open design, *semi-outdoor* spaces allow for better air circulation, facilitating the flow of cool air from outside, as well as reducing the heat that enters the interior spaces of the house. Culturally, *semi-outdoor* space in Baduy houses is very important in maintaining the principle of togetherness and close social relations in the community. This is reflected in the function of *sosompang* as a social meeting place, where interaction between residents can occur naturally. On the other hand, in terms of climate adaptation, *sosompang* also provides protection against direct exposure to sunlight and rain, as it has a roof that protects but still allows fresh air to flow. This *semi-outdoor* space also serves as a link between the inside and outside of the house, creating a space that is not too closed or open. This shows a cultural adaptation to the tropical climate that prioritizes occupant comfort by utilizing natural elements such as air circulation, natural lighting, and connectedness to the natural surroundings. This *semi-outdoor* space is basically a cultural adaptation that supports the living comfort of the Baduy community, who always try to maintain harmony with nature, while still maintaining social continuity and togetherness between residents.

D. Integration of Tropical Architecture Concepts with Measurement Results

In Baduy houses, design and elements such as *sosompang* (*semi-outdoor* terrace) play an important role in adapting to the hot tropical climate, by keeping the temperature inside the

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house comfortable. The existence of open *semi-outdoor* spaces allows the flow of cool air from outside, which supports the decrease of temperature in the main rooms of the house. This may help explain the decrease in temperature that occurred from 2:00 pm to 6:00 pm in the results, which occurred after sunlight exposure began to decrease. In addition, the orientation of the house facing north or south, as well as the use of natural building materials such as bamboo and wood, serve to reduce heat entering the house, as explained in the discussion related to building orientation and roofing materials. With a design that utilizes natural ventilation through gaps in the woven bamboo walls and open spaces, Baduy houses can maintain a relatively stable temperature, despite fluctuations in the temperature of the environment outside.

The thermal performance of Sulah Nyanda House is influenced by various factors, including the position and orientation of the building, the materials used, and the design of *semi-outdoor* spaces that allow for optimal air movement. The success of the natural ventilation system in Baduy houses, which is seen in the decrease of temperature in the afternoon, shows that the integration of cultural elements and building design in harmony with the tropical climate can produce stable thermal comfort, despite significant variations in outside temperature.

The results of the research on the Sulah Nyanda House of Baduy Traditional Village show that the application of traditional tropical architecture is able to support thermal comfort through elements such as high roofs, natural ventilation openings, and light and porous local materials. This is in line with tropical architecture theory that emphasizes the importance of airflow, temperature control, and the use of materials that are suitable for tropical climates (Latifah et al., 2013; Suprayitno, 2018). The stilt structure of the house and *semi-outdoor* spaces also play an important role in preventing heat radiation from the ground and providing a thermal transition zone, in accordance with the research findings of Handoko & Ikaputra (2019)

This research supports the study of Widyarti et al. (2012) which found that the traditional design of Rumah Sulah Nyanda allows for stable temperature fluctuations with daily temperature peaks less extreme than the outside environment. However, this study also highlights the need to re-evaluate the thermal performance of Rumah Sulah Nyanda in the context of climate change and the growing impact of global warming. As such, this study expands the understanding of the adaptation of traditional designs to modern climate challenges. The main contribution of this research to the study of tropical architecture is to reinforce the relevance of traditional principles in sustainable design. In addition, this research provides an empirical basis for evaluating the integration of local wisdom with modern architectural theory, particularly in the context of thermal comfort in the tropics.

3.5 Recommendations for the Tropical Architecture Concept of Sulah Nyanda Traditional House

Sulah Nyanda House has natural ventilation through the woven bamboo walls, but the concept of *cross ventilation* has not been fully implemented. It is recommended to add openings facing each other on the side of the wall to increase airflow and accelerate air turnover in the room. In accordance with the opinion of Imran (2018), optimal ventilation can be achieved if the air flow comes from the front or side of the building, with openings that support the cross ventilation system.

The management of the external environment, including the planting of vegetation, has an important function in regulating microclimates, such as sunlight and wind, by acting as shading or directing wind flow (Nugroho, 2021). Therefore, vegetation around Rumah Sulah

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Nyanda can be optimized to create natural shade. Planting shady trees strategically on the west and east sides of the house can reduce direct sunlight exposure, resulting in a more stable indoor temperature. Tall trees should be placed on the west side, while bushes are more suitable for planting on the east side (Imran, 2018).

In the tropics, a roof with a terrace plays an important role in maintaining a comfortable home, both during hot and rainy weather. In addition to supporting energy efficiency through natural lighting and ventilation, it can also reduce solar radiation entering the room, protect from rainwater, and create shadows that keep the temperature inside the house comfortable. Some Sulah Nyanda Traditional Houses are still not equipped with terraces on the side openings, so the addition of this element is needed. Windows can be made in two types: first, integrated into the main roof structure, and second, separated from the roof structure and attached to the wall. The shape can also be customized, either sloping to follow the roof design or flat, depending on the preference and design of the windows used (Latif et al., 2017).

4. CONCLUSION

The application of tropical architecture concept to Sulah Nyanda House in Baduy Traditional Village shows a harmonious integration between cultural elements, tropical climate, and building design. Rumah Baduy, with its stilt structure, bamboo material, and palm fiber roof, is designed to overcome the challenges of a hot and humid tropical climate. The utilization of *semi-outdoor* spaces*,* such as *sosompang,* supports optimal air circulation, creating thermal comfort for the occupants. The north- or south-facing orientation of the building maximizes natural lighting, while the tight, lined arrangement of spaces plays a role in reducing direct solar heat exposure.

Research on the thermal performance of Sulah Nyanda House shows that temperature fluctuations are well regulated by the building design, with stable temperatures at night and a decrease in temperature occurring after sun exposure is reduced. This shows that the concept of Baduy traditional house is able to adapt to the tropical climate, by considering factors such as natural ventilation, building orientation, and the use of environmentally friendly local materials. Even so, some recommendations in the form of maximizing the concept of cross ventilation, arranging vegetation as shading and adding teritisan to the openings of Sulah Nyanda House need to be done to improve the comfort of the occupants of the house.

Overall, the application of tropical architecture in Rumah Sulah Nyanda not only creates thermal comfort and energy efficiency, but also reflects the local wisdom values of the Baduy community that prioritizes harmony with nature. However, with the increasing impact of global warming and climate change, further research is needed to evaluate the thermal performance of Rumah Sulah Nyanda in the present. This research is important to determine whether the tropical architectural design of this house is still able to maintain temperature comfort under changing climate conditions. In addition, an in-depth analysis of the dimensions and placement of elements such as openings is also needed to understand their effect on air circulation and overall thermal comfort. Thus, this research can serve as a basis for the development and preservation of sustainable traditional architecture in the future.

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