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Sustainable Adaptation of Traditional Architecture to Local Climate: Case Study of Tajur Traditional House

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ABSTRACT

Sustainable architecture has gained increasing attention in response to the ongoing climate crisis. Traditional architecture, which is shaped by local culture, geography, and climate, plays a vital role in maintaining local wisdom and preserving the genius loci. This type of architecture often involves traditional materials and techniques passed down through generations. In Indonesia, traditional houses, such as those found in Pasanggrahan, Purwakarta Regency, West Java, exemplify this approach by reflecting the region's climate and cultural conditions. Despite their significance, research on traditional Indonesian house architecture remains limited. This study aims to explore the architectural characteristics of houses in Tajur Village, focusing on material use, building and village typology, and how they respond to the local climate. Using a descriptive qualitative method, data was collected through interviews, documentation, and observations. The findings show that Tajur Village homes are highly adapted to the local climate through their materials, design, and structure. These climate-responsive solutions can inspire sustainable architecture that addresses the challenges of climate change.

INTRODUCTION

Sustainable architecture has received increasing attention over the last few years in response to the climate crisis the world is facing. Traditional houses reflect climate conditions, cultural and environmental surrounding areas, and are identified as a potential source of inspiration as a basis for sustainable design (Nguyen et al., 2019). Traditional houses in countries such as the Philippines, China, Taiwan, and Turkey have demonstrated strategies for adapting to the local climate (Çetin Murat & Bekişoğlu, 2022; Li et al., 2022; Mabborang et al., 2022; Zhang et al., 2022). No traditional building can be separated from the culture and geographical conditions of a tribe or community group. The shape of the building, spatial patterns and house ornaments provide this identity (Putra et al., 2021). The adaptation of a traditional house to the surrounding environment can be seen in the use of local materials and natural ventilation, as well as providing a comfortable and sustainable living environment (Alabsi et al., 2016; Avcı & Beyhan, 2023; Samodra et al., 2019).

Research on traditional houses has been conducted by various researchers. Several studies have focused on the building materials used in these houses. The use of local materials such as bamboo, wood and clay can increase sustainability and resilience to local climate conditions (Sriwardani & Savitri, 2019; Wibowo, 2020). There is also a study on village spatial planning and the orientation of houses concerning the wind and local weather. This study evaluated the orientation to wind and sun, position, air

ventilation strategies, openings, and material properties of the houses in relation to climate adaptation (Jin & Zhang, 2021; Juan et al., 2019; Nuryanto, 2019). Adaptation of traditional buildings to environmental sustainability is crucial (Jin & Zhang, 2021; Juan et al., 2019; Kaoula et al., 2022; Susilo & Prianto, 2023). As an effort to sustain traditional houses, a study was also conducted on community behavior regarding perceptions and adaptation strategies for climate change (Nurhayati et al., 2020).

The adaptation of traditional houses in Indonesia not only provides comfort but also demonstrates a sustainable approach to living in harmony with the environment. This makes them relevant and resilient in facing the challenges of climate change in Indonesia (Anisa, 2022; Nuryanto, 2020; Sudarwani, 2016). Indonesia, with its cultural diversity, has different traditional house architectures in each region. Several traditional house settlements have not yet been researched, one of which is Tajur Village in Purwakarta. Studying the traditional houses of Tajur Village can provide broader insights into designing modern buildings that are more environmentally friendly, sustainable, and resistant to the challenges of climate change.

The problem that can be researched in this study is the adaptation of traditional house buildings in Tajur Village to the local climate. The study aims to reveal the architectural characteristics of these houses that allow them to survive for a long time in mountain climates, focusing on the use of climate-responsive building materials and sustainable architecture. This study will analytically describe the values contained in a traditional house. Therefore, this research will delve deeper into the use of materials and building forms in response to the local climate and how to withstand climate change in the future.

Traditional architecture refers to building designs that are shaped by local culture, geographic conditions, and local climate. This term covers various forms of building that use traditional construction materials and techniques passed down from generation to generation. Traditional architecture is not just aesthetic, it also reflects a deep understanding of the environment and human needs unique to a particular place. Rapport (Duque, 2022) states that traditional architecture is the result of the process of human adaptation to their physical and social environment, thereby creating optimal and sustainable solutions.

Architectural adaptation to climate is an effort to design buildings that can optimize thermal comfort for their occupants through a passive approach. This approach involves the use of design elements that utilize natural conditions such as wind, sunlight, and humidity to regulate the temperature and air quality in the building. According to Imran (2013), factors that influence a building in a room are ventilation, building orientation, vegetation arrangement and use of building materials.

On traditional architecture, elements of adaptation to this climate are often seen in the form and function of buildings. Some commonly found elements include: a) Roof: The shape of the roof is sharply sloping to channel rainwater and speed up air flow. b)

Building Materials: Use of natural materials such as wood and bamboo which have good thermal insulation properties. c) Space Layout: Space design that allows maximum air circulation and reduces heat (Muttaqi & Suparwoko, 2020).

Thermal comfort in architecture relates to a building's ability to maintain a comfortable internal temperature for its occupants. In the context of traditional architecture, thermal comfort is achieved through passive design that utilizes natural elements to regulate thermal conditions.

The adaptation of traditional architecture to the local climate is also closely related to the concepts of sustainability and energy conservation. Design that optimizes the use of natural resources and reduces dependence on fossil energy is one of the main principles of sustainable architecture. According to Steele (Hidayatulloh & Anisa, 2022), sustainable architecture can meet and balance human needs with environmental sustainability through wise design practices for future generations.

RESEARCH METHOD

This research applies a qualitative descriptive method to detail what happens in the field in through written descriptions. The research approach uses a case study of the Tajur Village Traditional House, which still uses local materials and adapts to the surrounding climate. The methods and approaches utilize secondary data analysis obtained from research locations through surveys and observations. The research process was conducted through field survey activities supported by documentation (direct observation). Data collection has two types: primary data obtained by directly visiting the research site and secondary data collected from literature studies on traditional Indonesian architecture. There are three ways to collect data: observation, interviews with residents, and documentation in the form of photos and drawings.

RESULTS AND DISCUSSION

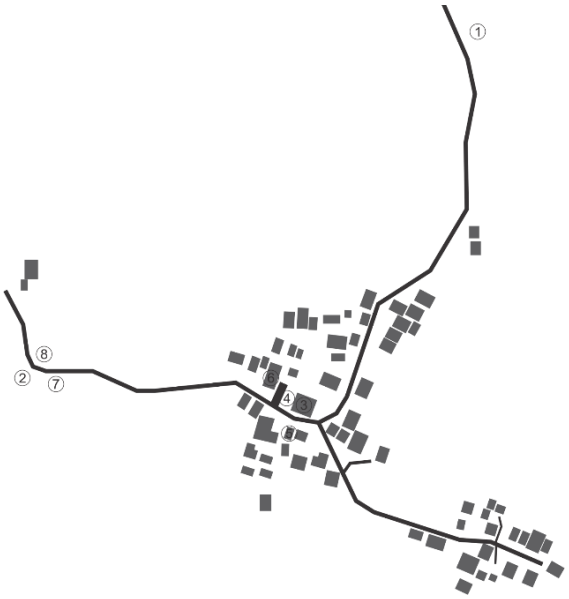
Research Area

Tajur Village is in Pasanggrahan, Purwakarta Regency, West Java Province (Fig. 1). Based on its geographical location, the village is located at the foot of Mount Burangrang faces directly onto the body of the mountain and is surrounded by several hills. The village area borders the forest and has cold weather because it is close to the mountains.

Figure 1. Main location of Tajur Village, Purwakarta region (author documentation)

Vilage Pattern

Tajur Village has a linear village pattern following the shape of the road. The houses in Tajur Village are lined up along the road and the building facades face the road. There is only one road to Tajur Village, then in the residential area the road branches



into two roads. This road branch is the boundary between RT 10 and RT 11.

Figure 2. Tajur Village Pattern Mapping. (1) resident's grave area; (2) community figures grave area; (3) mosque; (4) field; (5) gazebo; (6) official residence;(7) Panembahan waterfall; (8) Heroes Monument. (Author Documentation)

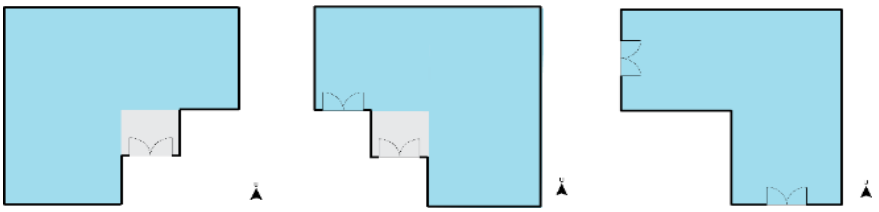
Traditional House of Tajur Village

The facade in Figure (3) is an official residence used by regional officials. The house has a typology I shape with one floor and the facade facing the street. An outline of the architectural characteristics of Tajur Village houses, namely that they are made from bamboo booths, the structure of the house is in the form of stilts with floors that are not directly above the ground, and the roofs are made of tiles.

Figure 3. Façade of Traditional House (Author Documentation)

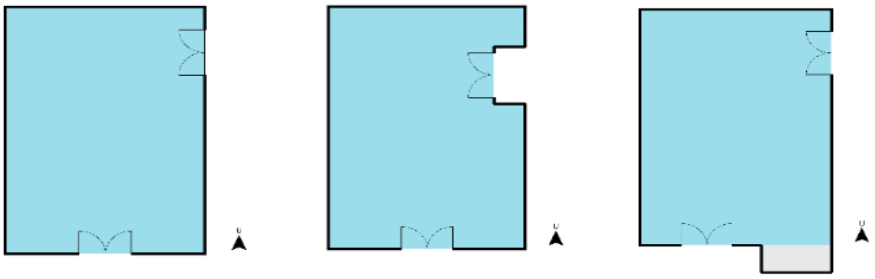
Typology of Traditional Houses

The facade axes of the Tajur Village houses are oriented along two axes, namely the north- south and east-west facades with the road remaining the center of orientation for the front of the house. In general, there is no significant difference in house architecture, has a one- story house, house size depends on the land area and homeowner's capabilities.



(a) (b) (c)

Figure 4. Traditional House L Form Typology in the Tajur Village (Author Documentation)



(a) (b) (c)

Figure 5. Traditional House I Form Typology in the Tajur Village (Author Documentation)

Interior of Traditional House

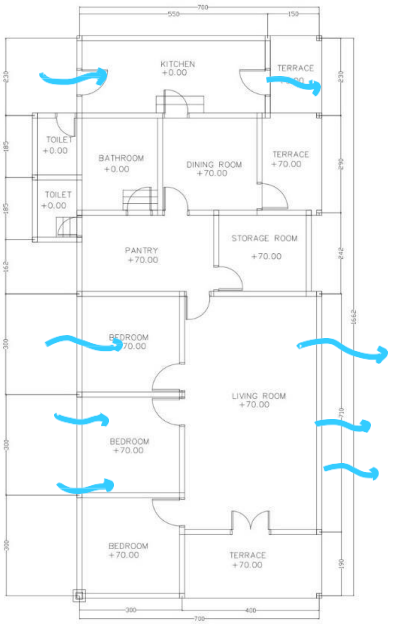


Figure 6. Floor plan of Traditional House and the breeze flow (Author Documentation)

The research analyzed that one of the houses in Tajur Village functioned as an official residence. The shape of the house is included in the I-shaped and large typology. In general, what differentiates it from other residents' houses is only the size of the room. Every room in a traditional house has a window that functions as cross circulation in the house. The interior of the building also uses minimal partitions to allow good ventilation in the house.

(a) (b)

Figure 7. House interior (a) living room; (b) plafond using bamboo (Author Documentation)

The house's interior rooms were divided by a wall made of woven bamboo. Bamboo woven allows ventilation and good air circulation in the house due to the gaps in the walls. This material has flexible properties. The column structure of the house uses wood- based materials to make the house in Tajur Village strong and safe against earthquakes. The ceiling in the house uses bamboo woven like the walls (Figure 7b). The space between the ceiling and the roof functions to cool the inside of the house and buffer from the sun's heat absorbed by the roof.

Traditional House Structure

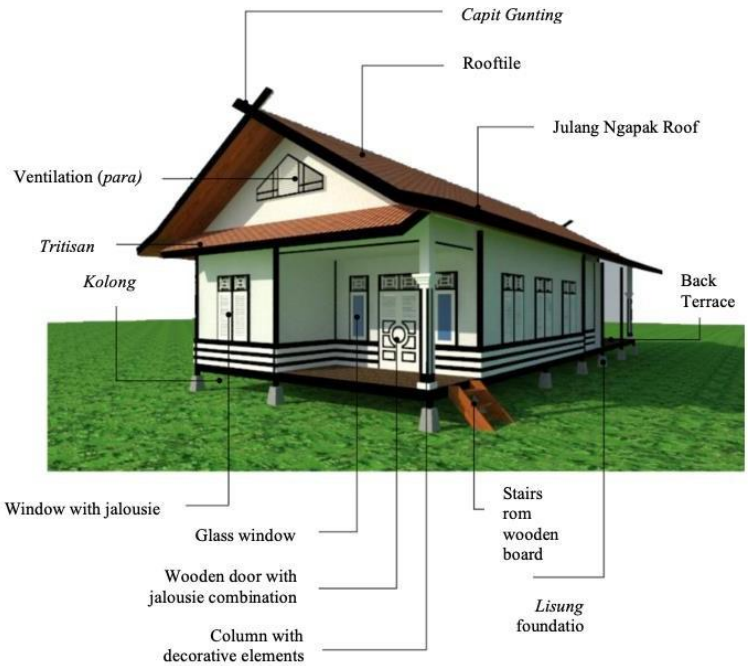


Figure 8. Schematic diagram of a traditional house with structure identification (Author Documentation)

Figure 9. The roof covering uses tiles (Author Documentation)

People are switching from using palm fiber to tile for roof coverings due to practical installation, ease of maintenance, and non-flammability. This change results in the building becoming warmer, as tile roofs more easily capture the sun's heat. The houses in Tajur Village have roof ventilation, which allows wind to move through the house and cool it from the heat captured by the roof covering. Additionally, wide roofs are very effective as shade from the hot sun.

(a) (b)

(c) (d)

Figure 10. Foundation Construction. (a) form of *Pasagi* foundation; (b) the shape of the *Lisung* foundation; (c) the function under the house is to become a roof storage area; (d) steps to access the house (Author Documentation)

Most traditional house foundations use *lisung* foundations, which are narrower at the top than at the bottom (Figure 10b). These foundations are made from a mixture of cement and sand to strengthen the structure of the stilt houses. Some other houses in this village use square foundations (*pasagi*) (Figure 10a) and round foundations (*buleud*). The foundation height in traditional village houses varies between 30 cm and 70 cm. Access to the stilt houses is provided by several steps made of wooden planks (Figure 10d).

Additionally, the space beneath the stilt houses is used for storing roof tiles or firewood (Figure 10c) and serves as an adaptation to the surrounding weather, anticipating rain and flooding. There is a gap between the ground and the floor of the buildings to mitigate material damage from weathering due to water, damp soil, and insects. This space also helps the house withstand high-speed winds and mitigates earthquake damage. The entire floor of the house is covered with wooden planks made from locally sourced wood, which helps regulate the room temperature by adjusting to the surrounding climate.

(a) (b)

Figure 11. House wall. (a) the function under the house is to become a roof storage area; (b) the shape of the house foundation (Author Documentation)

The walls of the houses in Tajur Village use two types of materials. First, wooden walls are on the outermost layer of the house walls. The outermost layer walls are painted black and white. The second layer of walls was made for the interior made from woven bamboo and painted with white color. The windows in the house are easy to open with the type of window using wooden grilles. Apart from functioning to maintain the privacy of activities inside the house, it also facilitates circulation at the user's body level even when the windows are closed. The windows use glass to make it easier for light to enter the house.

CONCLUSION

Based on the discussion above, it can be concluded regarding the adaptation of traditional houses to the surrounding climate was the location of Tajur Village is in the mountainous area of Purwakara Regency, which geographically has cooler weather because it is in the highlands. The orientation of the facade of a traditional house always faces the village road and follows two axes, namely north-south or west-east. In the house building typology of Tajur Village, there are only two types of building masses, namely I and L shapes with houses shaped like stilts and only having one floor. Architecturally, buildings are closely related to local location, culture and climate for comfort and sustainable home building. The application of building adaptation to the surrounding climate is found in door and window openings, the use of local materials such as wood, bamboo walls and clay roof tiles, the roof space allows the building to adapt to the surrounding weather and

provides comfort to its users.

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